SCIENTIFIC AMERICAN

DEVELOPMENT OF THE U.S. NAVY SINCE THE SPANISH WAR

U.S. BATTLESHIP GEORGIA
AND CLASS

C.M.cKNIGHT-SMITH

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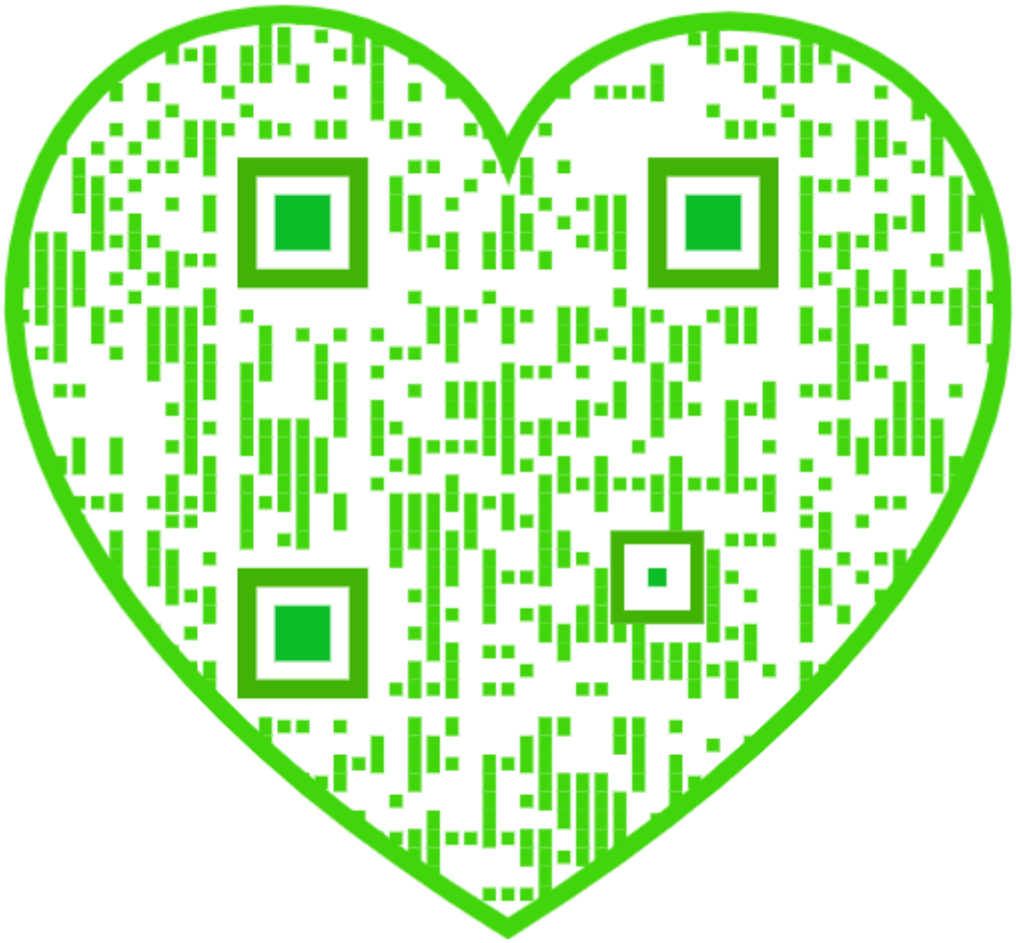

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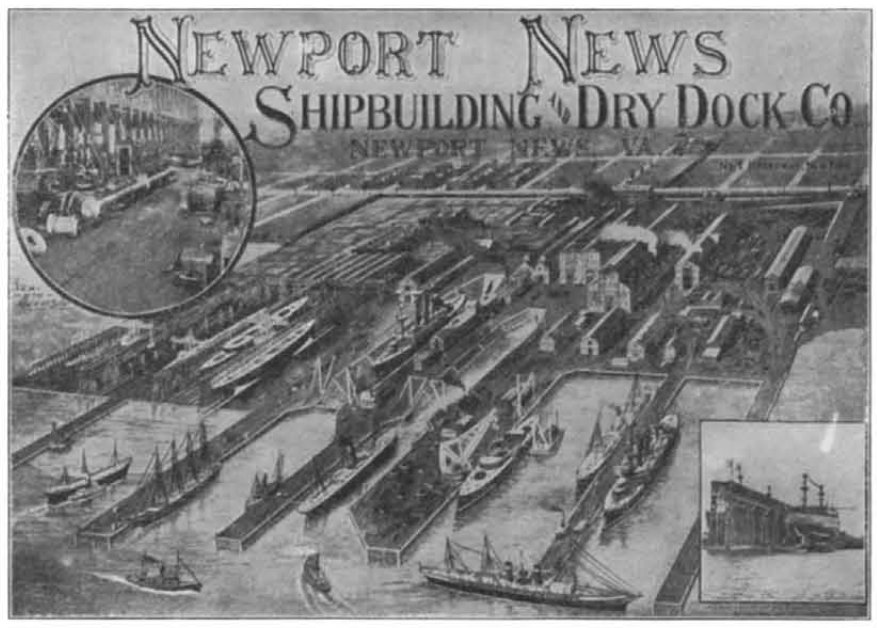

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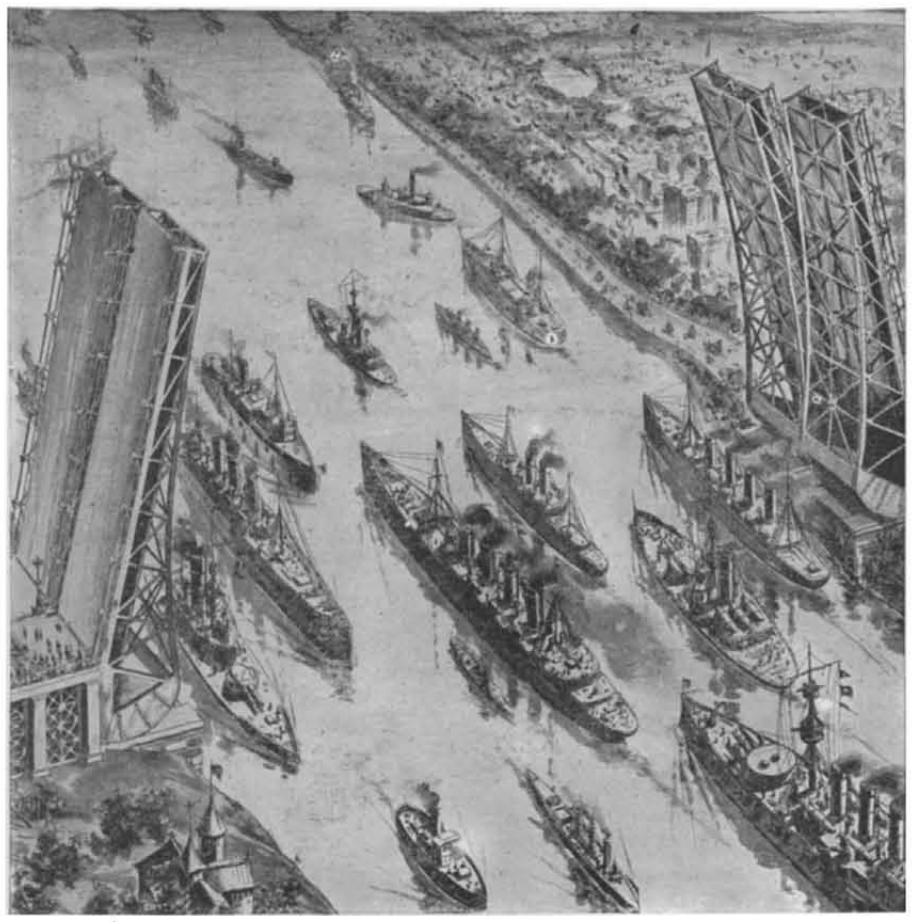

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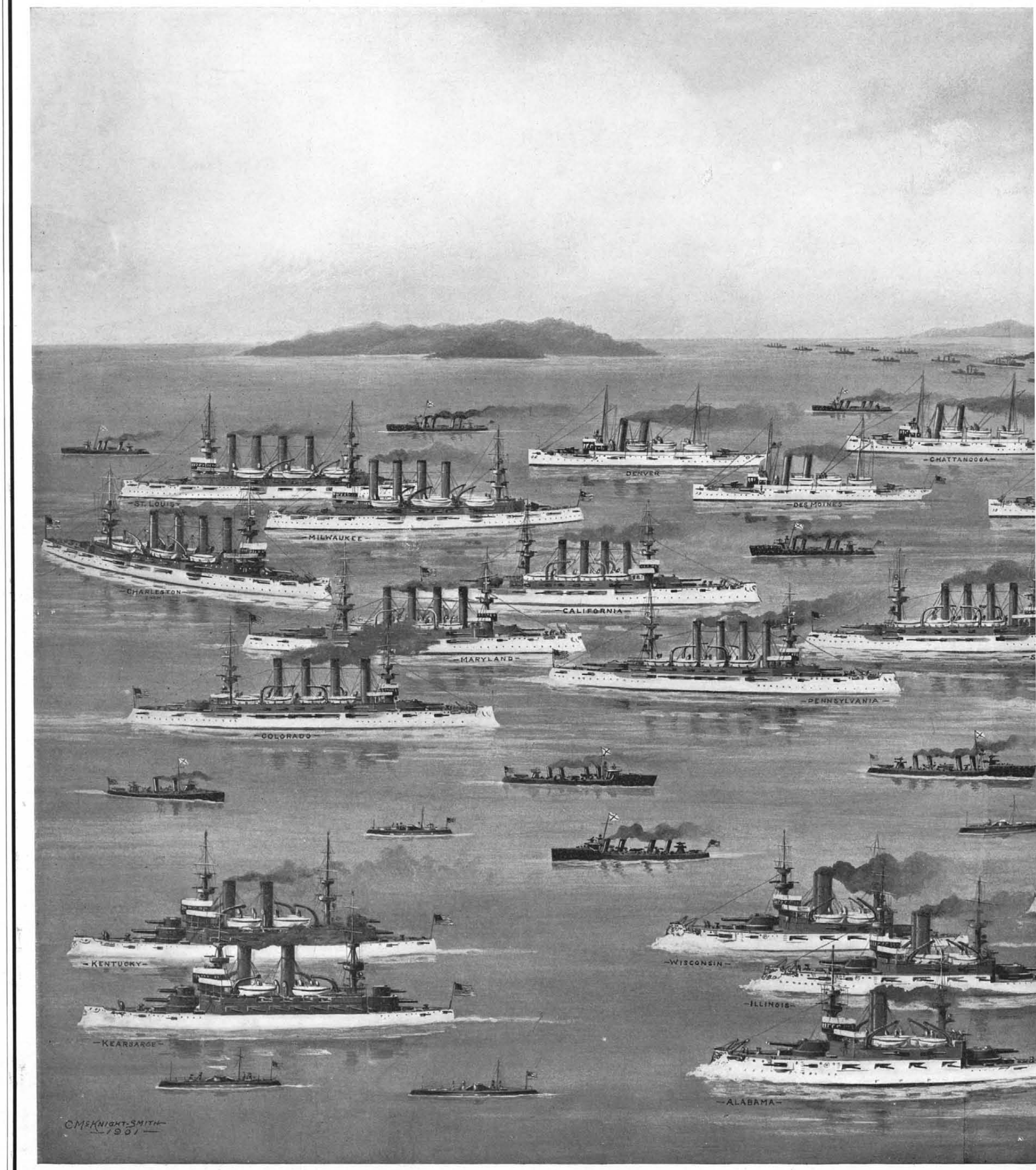

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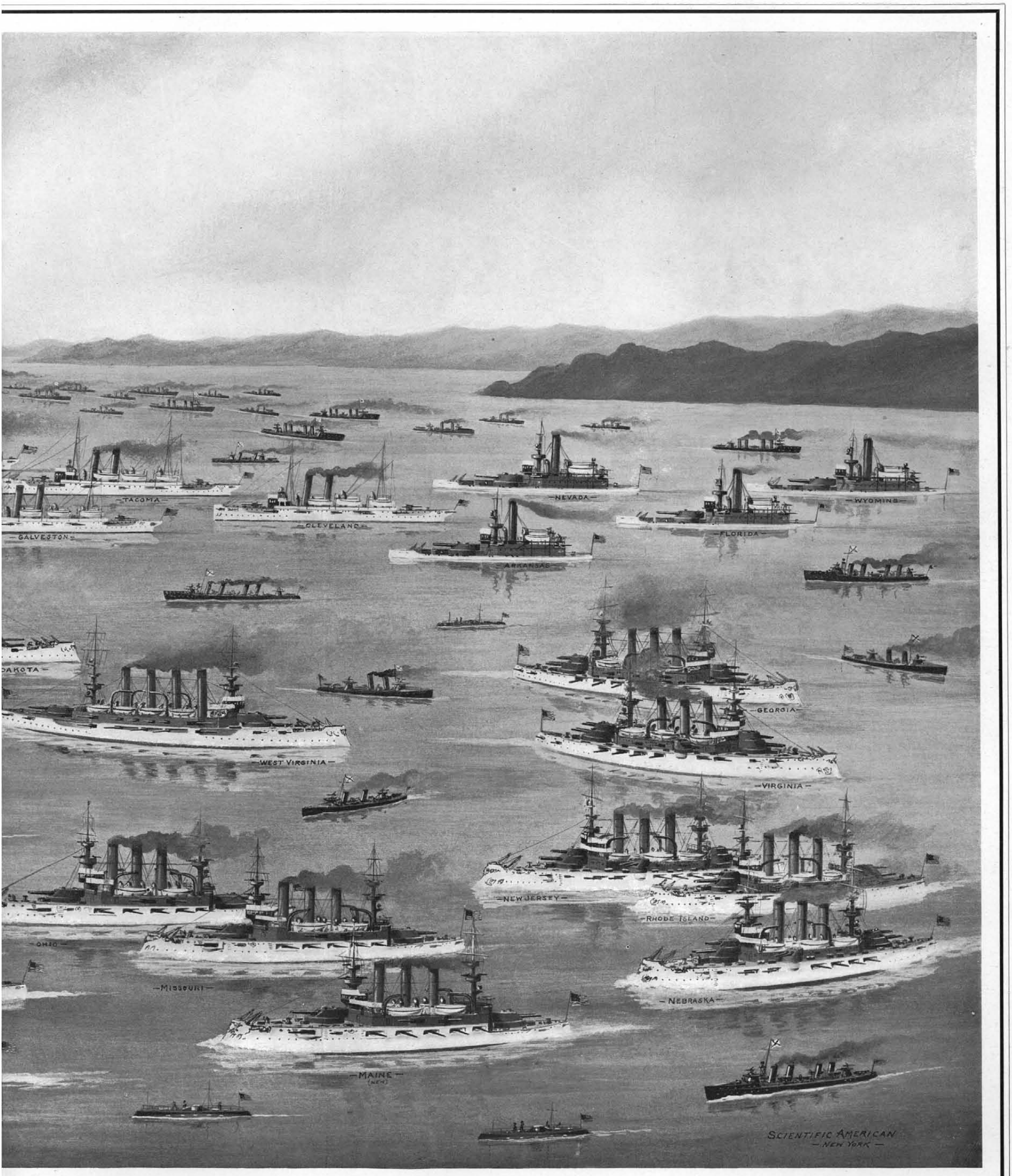
In the Above Fleet Will be Found: 13 Battleships, 6 Armored Cruisers, 3 Semi-Armored Cruisers, 6 Protected C

Of these vessels, 5 Battleships, 12 Destroyers, 22 Torp

The Growth of the United States Na



iers, 4 Monitors, 23 Torpedo-Boats, 16 Torpedo-Boat Destroyers, and 7 Submarine Boats; 78 Vessels in all.

Boats, and 4 Submarines have been completed.

Since the Spanish-American War.

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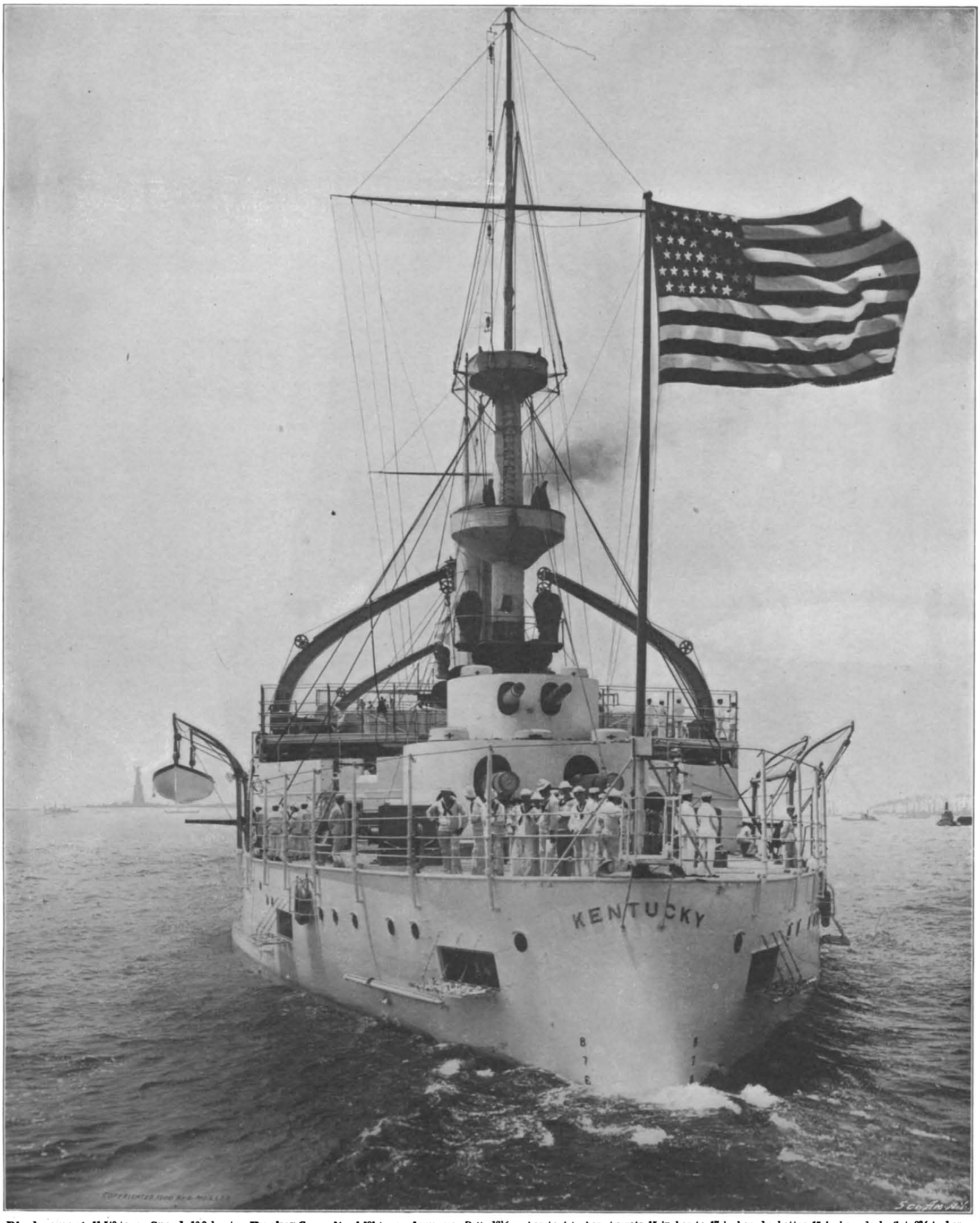

Displacement, 11,540 tons. **Speed,** 16.9 knots. **Bunker Capacity,** 1,591 tons. **Armor:** Belt, 16½ inches to 4 inches; turrets, 15 inches to 17 inches; barbettes, 15 inches: deck: flat, 2¾ inches, slopes, 3 inches to 5 inches. **Batteries:** Four 13-inch B. L.; four 8-inch B. L.; fourteen 5-inch R. F.; twenty 6-pounders; eight 1-pounders; four Colts; two 3-inch field guns. **Torpedo Tubes,** 4. **Complement,** 589.

FIRST-CLASS BATTLESHIP "KENTUCKY." SISTER SHIP, "KEARSARGE."—[See page 375.]

SCIENTIFIC AMERICAN
ESTABLISHED 1845

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MUNN & CO., 361 Broadway, New York.

NEW YORK, SATURDAY, DECEMBER 14, 1901.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

PEACE AND A POWERFUL NAVY.

We are building up a powerful navy for the express purpose of preserving the peace, and every battleship and cruiser that hoists her flag in commission is a pledge that the peace will be kept. In the past few years we have made wonderful advancement in possessions, in commerce, and in wealth; and great as have been the additions to our naval strength, they have been trivial in comparison to the enlargement of the national interests, which the Navy is called upon to defend.

In all sincerity we proclaim ourselves to be a peace-loving people, and in adding ship to ship we believe we are making more remote that day when the ambitions of other nations might have led them to violate those clearly-stated and easily-understood principles, by which we wish to regulate our conduct as one of the great nations of the world. In an earlier age, to possess the implements of war was to make haste to use them; to-day the nations that maintain the greatest armaments appear to be the most reluctant to set them in motion. It is certain that so long as our naval strength is adequate to our necessities, war will never be thrust upon us.

As a journal devoted to the peaceful arts, we present this delineation and description of our growth as a naval power, in the firm belief that the first and last duty of our navy, the fundamental object of its existence, is to place the nation in a position of defense so secure and unassailable that we may pursue the arts of peace without fear of molestation, or even the shadow of affront.

The spirit which at once begets and controls our determination to have a navy commensurate with our national standing was admirably defined in a recent utterance of the Secretary of State: "There will be no more surrender of our rights than there will be violation of the rights of others. No wantonness of strength will ever induce us to drive a hard bargain with another nation because it is weak, nor will any fear of ignoble criticism tempt us to insult or defy a great Power because it is strong."

WARSHIP CONSTRUCTION AT THE GOVERNMENT NAVY YARDS.

Popular delusions die hard; and one of the most pernicious and persistent of these is the belief that warship construction when done by the government is poorly done, and costs more than it does at private yards. There was a time, it is true, when the navy yards could not compete with private firms; but that was a day when the yards were overridden by political influence, and encumbered with lazy incompetents, who owed their positions to "pull" with the local politicians. Thanks to the trenchant reforms instituted and carried through, largely by the efforts of the present Chief Constructor, Rear-Admiral Bowles, our navy yards have been entirely emancipated from politics, and the organization, plant, discipline and character of work turned out, have been brought up to a standard that is fully equal to that of the best private establishments.

The Naval Constructors believe, and we fully agree with them, that the time has come when it would be to the nation's advantage to have a certain proportion of its ships constructed in government yards. The plant and the working staff at New York and Boston have been brought up to such a state of efficiency that the largest battleships could be constructed with economy and great efficiency. The high cost of the "Texas," the "Maine" and other government-built ships cannot be quoted against this statement, since those vessels were built before the yards were reorganized, and when the plant was old and inefficient.

The construction of ships in government yards would have a two-fold advantage. It would stimulate private builders to exhibit some of that dispatch, which has recently been so conspicuously absent (some of our battleships are a year and a half, and our torpedo-boats two and a half to three years behind their contract date), and it would be possible to keep the well-trained navy yard forces continuously at work, instead of having to discharge a large part of them, whenever routine repair work is slack.

The practice of building some of the warships in government yards is followed to advantage in the leading European navies. We should adopt it here.

OUR NAVAL DEVELOPMENT SINCE THE WAR WITH SPAIN.

In undertaking to describe the growth of the United States navy since the war with Spain we were somewhat at a loss to determine the best basis on which to make the comparison between our standing in 1898 and in 1901; but since the special naval number which we published at that time served to make our readers thoroughly familiar with the ships that actually took part in the naval operations of 1898, we have decided that in the attempt to make clear our *post-bellum* progress, we cannot do better than eliminate the vessels that were in commission during the war, and give in the present number a description and illustration of every type of ship that has been either commissioned or completed, or is now under construction, or whose construction has been authorized since the war. Just how numerous and imposing will be this new navy may be judged from a glance at the inset drawing, showing the vessels grouped in one vast fleet. The effect of this illustration will be deepened by a study of the table showing the details of displacement, speed, armor and armament which will be found at the close of this issue. For a still more detailed description of the vessels, the reader is referred to the larger illustrations, which include one of every type of vessel shown in the general view of the fleet.

We wish, however, at the very outset to emphasize the fact that no one, even after such a careful study of our new navy as we have just suggested above, will obtain an adequate knowledge of the great advance which we have made since the war, unless he pays particular attention to the fact that the armor and guns carried by the new ships are vastly superior to those which won the victories of Santiago and Manila Bay. Gun for gun, thanks to improved gun steel and smokeless powder, the weapon of to-day delivers a blow which is in some cases nearly 100 per cent greater than that delivered by the same piece in 1898; while the armor with which the latest of our ships will be protected has from 20 to 25 per cent more power to resist penetration than the best armor carried by our vessels in the war, and from 40 to 50 per cent superiority over the older armor, that was fabricated before the introduction of the Harvey and Krupp systems of face-hardening. There is to be considered furthermore the great advantage conferred by the substitution of smokeless for the old smoke-producing powder. Recent testimony of naval officers in regard to the Santiago operations has shown how greatly our ships were impeded by the smoke from their own guns, some of the vessels being at times as completely bewildered as to the actual conditions of battle as if they were enveloped in a dense sea fog. In the new vessels, in spite of the greater rapidity of fire, and the enormously increased velocity and energy of the projectiles, the crashing discharge of the batteries will be accompanied merely by a slight haze, similar somewhat in its atmospheric effect to that of summer heat, and even this will be quickly dissipated. Moreover, improved mounts, perfect balancing of the guns, and telescopic sights, will enable the gunner to keep his piece, except in a heavy seaway, continually upon the object; and it is pretty certain that if our ships are ever again called to cast loose their batteries in a naval engagement the efficiency of their gun-fire will be increased four-fold or more. There will be no such record as the 3 per cent, only, of hits, which was the best we could do in the fight with Cervera's fleet.

Nor must we in estimating the fighting value of our new navy forget that there has been a decided advance in that most vital element of a ship—motive power. The improvements in gun steel have been accompanied by improvements in steel for boilers, for shafting, and for the moving parts of engines. The old Scotch boiler, admirable as it is, has given place to the water-tube type with its rapid steaming abilities and its larger rate of horse power per unit of weight. The economy of weight in motive power, and the even greater saving of weight accomplished by better methods of armor-plate making, have enabled the naval constructor to allot a larger share of the total displacement to motive power, with the result that speeds have gone up from the 15 knots of the "Indiana" to the 18 and 19 knots of the "Maine" and "Virginia" classes.

Lastly, and perhaps most important of all, there is the fact that the new fleet is made up of vessels which are pre-eminently sea-going, with lofty freeboard, a greatly increased radius of action, and a much more generous provision for the comfort of the crew. This last feature, known technically as "habitability," is of inestimable importance in its effect upon the contentment and general *morale* of the ship's complement. Taken altogether, the assemblage of ships shown in our table is one of which we may justly be proud; and we feel that there is no more fitting time than this to speak a word in praise of the careful observation of the trend of foreign development, the discriminating selective judgment, the characteristic originality, and the great professional skill which have enabled the Bureaus of Construction, Ordnance and Steam Engineering to produce a fleet of vessels which, ship for ship, we believe to be the peers, and in some respects the superiors, of any that are built or building for the navies of the world to-day.

"REVOLUTIONIZING" NAVAL WARFARE.

The ponderous battleship, clothed with foot-thick armor, bristling with half a hundred guns, crammed with the costly products of the steel mill and the machine shop, and representing an investment of some seven millions of the nation's money, expresses our Twentieth Century ideal of the most perfect fighting machine for naval warfare. War is costly; upon the high seas it is enormously so. The history of naval warfare proves that there is no short cut to success, and certainly none by any byway of cheap, "kill-all" devices, warranted to deal out superlative destruction to the enemy at a minimum depletion of the national funds.

It is for very good reasons that, in the evolution of the modern navy, there has been a growing tendency to increase the size and cost of the individual unit. The law of evolution is as inexorable in a warship as in the processes of natural life; and in leading us to the best possible type it is scarcely less sure a guide. So complete is the interchange of ideas among the naval architects of the world, and so singularly free are they from that tendency to cling to national types, which in other spheres of activity prevents unfettered development, that we are justified in believing that the present make-up of our navies is about the best that could be devised for the work they have to do.

Naval development, then, has always moved in the direction of big units, that are slow and costly in construction, but represent, each, a vast concentration of fighting power, whether for attack or defense. Our battleships have grown in ten years from the 6,000 tons of a "Texas" to the 16,000 tons of a "Georgia," and our 5,000-ton cruiser "Chicago" of 1885 finds its counterpart in the 14,000-ton "California" of fifteen years later.

The history of modern naval development shows that inventors have been quick to appreciate the weak point in this policy of concentrating the fighting strength in a few large units rather than in many smaller ones; and periodically the naval world has been startled by the advent of small, cheap, easily-built devices, which at one fell stroke were to "blow" anywhere from one to seven million dollars' worth of ship "out of existence," and incidentally were to "revolutionize" the whole theory of naval construction.

The naval revolutionist is ever with us; and not even the contemplation of the long and steadily-growing list of naval engines of destruction that failed to destroy, deters each new "annihilator" from being duly heralded as sounding the death-knell of the battleship and the breech-loading rifle.

There are but few of us so young but we can remember the advent of the torpedo-boat, and the feverish haste with which the naval powers vied with each other in setting afloat whole squadrons of these now-discredited craft. For the torpedo-boat found its immediate answer, first in the rapid-fire gun and the torpedo-net, and then in the "destroyer"—a larger edition of itself, capable of running it down at sea and sinking it with the long-range rifles with which it is armed. The predicted revolution never took place, while the battleship continued to grow in size, power and costliness.

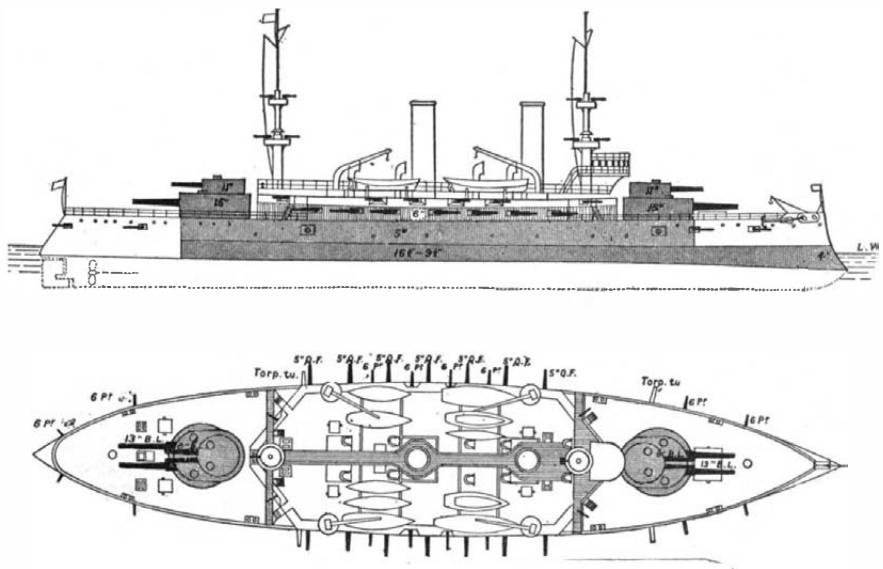
The ram was answerable for another speedy revolution that has yet to materialize. Great Britain built her "Polyphemus," and the United States her "Katahdin;" but the former is now doing some kind of obscure duty in the Portsmouth dockyard, while the latter has already, we believe, found an abiding refuge in our museum of naval curiosities. The turtle-backed submergible ram, difficult to detect, impossible to hit, or, if hit, deflecting the shot harmlessly from her rounded back, running amuck among a fleet of unwieldly battleships and sinking them with pitiless deliberation, presented on paper, it is true, an alluring picture; but the Spanish war came and went while the "Katahdin" lay rusting at her moorings.

The *raison d'être* of the torpedo-boat was, of course, to be found in the enormously destructive power of modern high explosives; and about the time that we awoke to the fact that the torpedo-boat had lost much of its terrors we were startled by the advent of the so-called "dynamite gun." Here at last was a demon of destruction which was worth just as many battleships as happened to come within range of its shells.

Why spend five years in building a 12,000-ton ship when, for the same cost, one could put afloat in one-fifth of the time a dozen fast little "dynamite cruisers," bearing the awesome name "Vesuvius," and each capable of sinking a battleship a minute by the simple expedient of tossing a quarter of a ton or so of dynamite aboard from her pneumatic guns? The Spanish war has passed into history, and with its passing was written the last chapter of the "dynamite cruiser" scare. It was a spectacular comedy, that midnight demonstration off Santiago Harbor, when the little craft was sent in to scatter "earthquakes" among the rocky bluffs of the Cuban coast. Later, on the morning of that memorable sortie from Santiago Harbor, the destroyers were the first to be destroyed, while it was a shell from the 13-inch gun of a battleship that caused the last of the fleeing enemy to strike colors and run for the shore.

The latest annihilator of the battleship and big armored cruiser is the submarine boat. Far be it from us to deny that this type of vessel may possess tactical and strategetical possibilities, which it only requires the test of actual war to determine. Used in connection with a system of harbor defense the submarine will exert considerable moral, if not material, powers; and doubtless the possession of a few of these vessels by a blockaded port would cause the investing ships to keep continually on the move, while they would be the cause of much nervous strain and justified anxiety on the part of the enemy. But there is little likelihood that the submarine boat, any more than the torpedo shell, the ram or the torpedo-boat, will drive the big fighting ship from the high seas. The submarine boat, when submerged, is only less able to see the enemy than is a torpedo-boat at the surface when enveloped in the densest of fogs, and the impossibility of sighting the enemy, or keeping close touch upon his course, reduces enormously the chances of getting in the vital blow. We shall build submarines in greater or less numbers, but from the position of undue importance which they have taken at the appearance of the first successful type, they will be relegated, like all previous "annihilators," to their proper subsidiary position among the fighting units that go to make up the navy as a whole. So, too, with the dirigible torpedo controlled by aerial impulses, of which we are beginning to hear again, and of which we shall doubtless hear much more in the near future. It is certainly awe-inspiring—this vision of a solitary operator, sitting secure on some headland point on shore, or within his armored station on a ship, controlling by the magic Hertzian waves the course of a little death-dealing torpedo craft, and delivering its torpedo with unerring aim at the unsuspecting enemy. An ideal device, were it but practical; which in the nature of things it never will be, except under such a favorable conjunction of wind, weather and motionless ship, as one might wait for throughout a whole naval campaign and never secure.

There has been much evolution but no revolution in the deliberate growth of the fighting ship to its present size and power; and to the navy that can concentrate in greatest numbers the combination of a big ship, well-protected guns, a steady platform, a true eye, a quiet nerve, unflinching courage, and faultless discipline will the victory of the future belong.



Gun and Armor Plan; "Kearsarge" and "Kentucky."

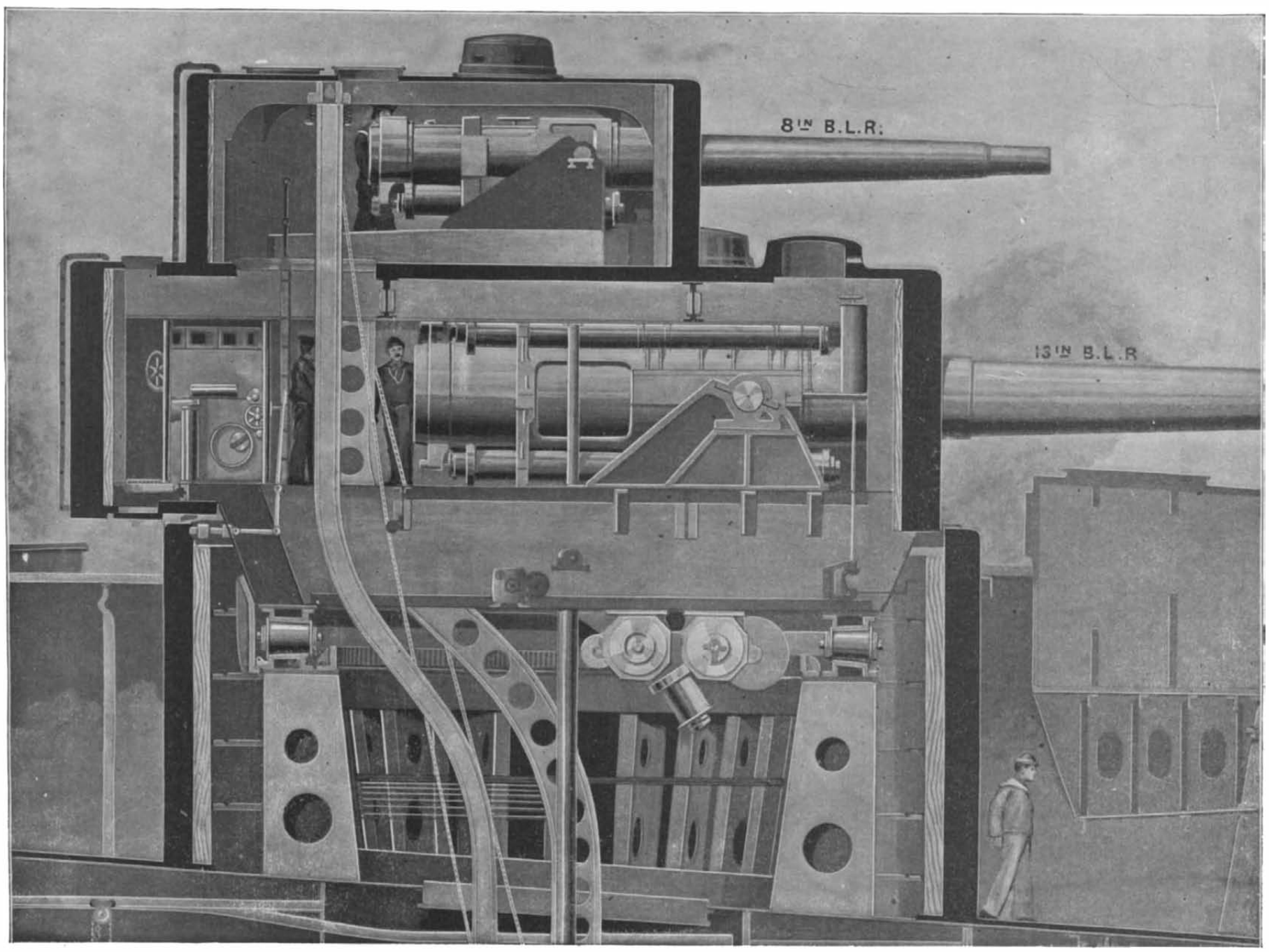
Battleships.

BATTLESHIPS "KEARSARGE" AND "KENTUCKY."

The first addition to be made after the close of the Spanish war to our small fleet of battleships (we had but four first-class battleships in commission during the struggle) consisted of two sister ships, the "Kearsarge" and "Kentucky," of about the same displacement and speed as the "Iowa," but differing radically in their armament from that vessel.

The most novel feature of the "Kearsarge" was the introduction of the now-famous superposed turret, over which there has been waged one of the most strenuous controversies of modern times. The object aimed at in this device is the securing of the greatest possible arc of fire for the various guns, and particularly for the 8-inch rifles. It was considered that by dispensing with four of the eight 8-inch guns as installed on the "Oregon," and placing the remaining guns and turrets on the roof of the 13-inch gun turrets, there would be the same concentration on either beam and also a dead-ahead and dead-astern fire, which would not be accompanied with any inconvenience to the 13-inch gun turrets. There would thus be a complete saving of the weight of four guns, two 8-inch turrets, and the necessary ammunition hoists, turning gears, etc. The idea of the double turret was from the first very strongly opposed by the Naval Bureau of Construction, both on structural and military grounds, an opposition which has at last succeeded in excluding the system altogether from our latest battleships.

Briefly stated, the structural objections are: The concentration of weight so near the ends of the vessel, tending to impair her seaworthiness; the risks in docking due to this concentration; the complication involved in concentrating at one point the large ammunition supply necessary for the four guns, and in the juxtaposition of the four ammunition hoists and the necessary power to work them; and last, and perhaps the chief of all, the abnormal stresses to which the substructure of the double turrets would be subjected from the simultaneous recoil of four heavy



LONGITUDINAL SECTION THROUGH BARBETTE AND SUPERPOSED TURRET OF BATTLESHIP "KENTUCKY."

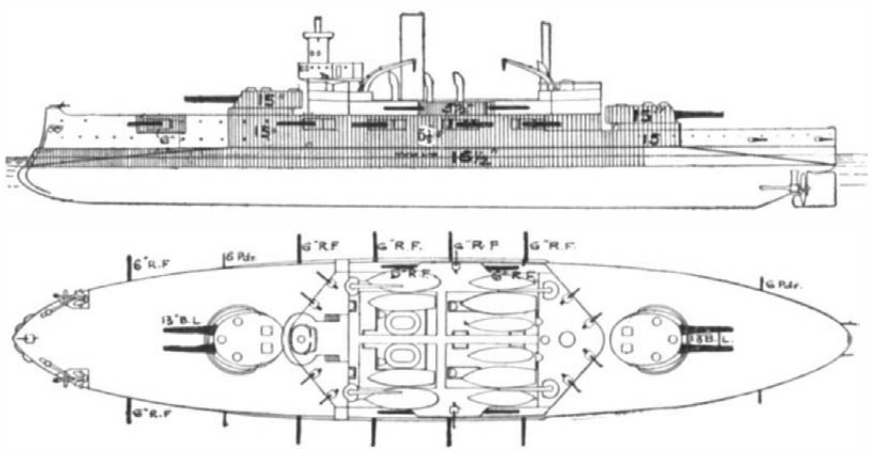
guns. These difficulties, however, have been cleverly met and removed.

The military objections, summed up, are as follows: First, the danger of all four guns being disabled by one successful shot; secondly, the reduction in the number of separate 8-inch gun positions, as compared with the "Oregon" type, and the attendant danger that in the last stages of a hard-fought action no 8-inch fire would be available on account of disablement; thirdly, the lack of mobility in the 8-inch guns, arising from the fact that they must be trained with the 13-inch guns beneath them, whereas it might be desirable to use the heavy guns on one portion of the ship and the lighter guns on some other; fourthly, the disconcerting effect upon the sighting of the other three guns in the turret by the sudden firing of the fourth gun, necessitating, as it probably would, the resighting of those pieces; and, lastly, the risk of intrusting the training of four great guns to the skill of a single individual.

The protective deck, which in the "Kearsarge" is 3 inches thick, is indicated in the sectional view herewith shown by the full black line at the bottom of the cut. Immediately upon it is built up the great circular wall of the barbette, which extends vertically to a few feet above the main deck of the vessel and is protected by 15 inches of armor. Immediately behind this armor is a backing of oak timber, which in its turn is backed up by the heavy steel framing of the barbette. Within the barbette, and at a height of about 8 or 10 feet above the protective deck, is a massive circular track, upon which is carried, and upon which rotates, the massive double turret, the rollers upon which the turret turns being clearly shown in the engraving. Just inside of the circle of rollers, and bolted to the circular table on which the track is placed, is a large circular rack, which is engaged by the turning gear with which the turret is operated. The power for turning the turret is supplied by two 50-horse power electric motors, which are located below the floor of the 13-inch turret. These motors revolve in the same direction, both driving through bevel gears a horizontal shaft which runs across the turret. The shaft carries at one end a right-hand and at the other end a left-hand worm, each of which engages with a worm wheel at the top end of a vertical shaft. At the lower end of the vertical shaft of each of the worm wheels is a pinion which meshes with the circular rack inside the barbette, thus driving the turret.

One 20-horse power motor is located under the central girder of the turret for the operation of each of the 13-inch ammunition hoists, the arrangement being shown in the illustration. Each 8-inch ammunition hoist is worked by a 6-horse power motor, and there are also special motors for elevating the 13-inch guns and for working the rammers which are located to the rear of the breech of these guns.

It will be noticed that whereas the front wall of the 13-inch turret lies within the circle of the barbette, the rear wall extends several feet beyond it. This is due to the fact that the section is taken on the longer axis of the turret, which is elliptical in shape, this form being better suited to the movements of the gun crews, reducing the unoccupied space at the sides and giving more space to the rear of the guns where it is needed.



Gun and Armor Plan; "Alabama" Class. "Alabama," "Wisconsin," "Illinois."

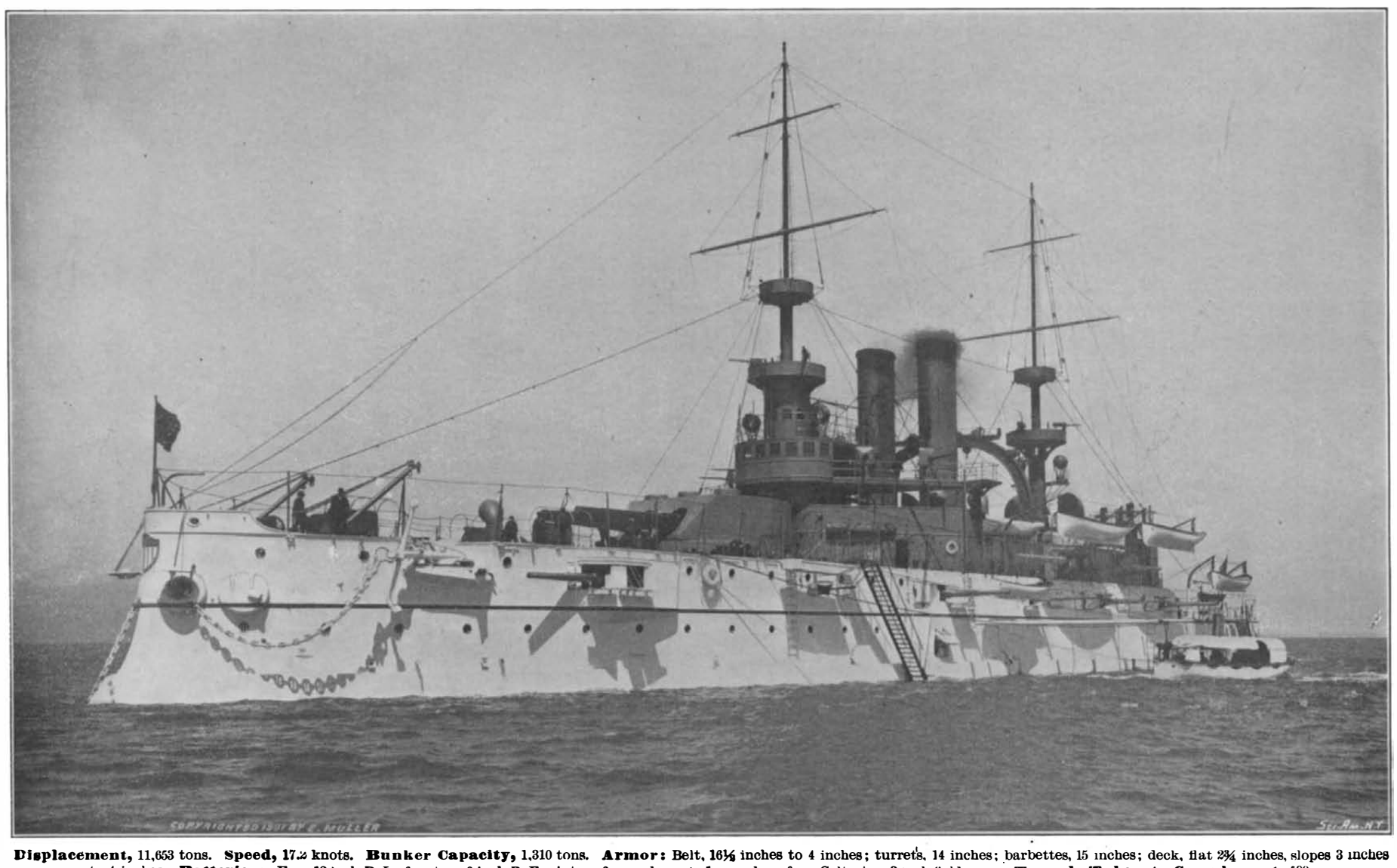
The elliptical turret is otherwise known as the balanced turret, the weights being so adjusted that there is practically no excess of load on any part of the turntable. The front walls of the turret are 17 inches in thickness, decreasing to 15 inches at the sides and rear.

As compared with the "Oregon," the "Kentucky" is 20 feet longer on the waterline, and has 3 feet more beam, 6 inches less draft and 1,252 tons more displacement. Her maximum coal supply of 1,591 tons of coal is about the same, and she has the same speed, 16.8 knots per hour. Her waterline belt, however, is carried up to the stem, tapering from 16½ inches amidships to 4 inches at the bow. The "Oregon" is unprotected at the waterline from the forward barbette to the stem and from the after barbette to the stern. Amidships the belt is 16½ inches at the top edge, 13½ inches at the waterline and 9½ inches at the lower edge. Above the waterline belt is a wall of 5-inch armor, extending to the gun deck. Upon the gun deck is located a broadside battery of fourteen 40-caliber 5-inch rapid-fire guns, and the whole battery is protected by 6 inches of armor with 2-inch steel bulkheads between each gun. At the barbettes transverse bulkheads extend across the vessel, protecting the central portion of the vessel from raking fire. At the level of the waterline these bulkheads are 10 and 12 inches in thickness; on the berth and gun decks they are 5 and 6 inches thick. The armor on the barbettes is 15 and 12½ inches, on the lower turrets 15 and 17, and on the upper turrets 9 and 11 inches in thickness. At the level of the top edge of the waterline belt will be a 2¾-inch protective deck, which will be thickened to 3 inches forward to the bow and 5 inches aft to the sternpost, the deck abaft the after barbette being increased in thickness to compensate for the absence of waterline protection.

The "Kentucky" and "Kearsarge," which were built at Newport News, are among the handsomest battleships afloat, and although the freeboard of 14 feet is low and the 5-inch gun is too light for the perforation of 6-inch armor except at rather close ranges, they are most serviceable ships and a valuable addition to our navy. At some future day we look to see the superposed turrets removed, the 8-inch guns emplaced in sponsons at the four corners of the broadside battery, and the fourteen 5-inch replaced by ten 6-inch rapid-fire guns.

"ALABAMA" CLASS—FIRST-CLASS BATTLESHIP "WISCONSIN."

On June 10, 1896, Congress authorized the construction of three first-class battleships, which have recently been completed and are known as the "Alabama," "Wisconsin" and "Illinois." The first named was constructed at the Cramps' Shipyard, the "Illinois" at the yard of the Newport News Shipbuilding Company, and the "Wisconsin," which is herewith illustrated, was built at the Union Iron Works, San Francisco. These fine vessels introduced a type of battleship that seems likely to become the standard type for the United States navy. Several new features are introduced in these ships, among which we may mention a change in the framing, the main frames being continuous from the keel to the armor shelf, and from the armor shelf to the upper deck. The longitudinal frames are built on a system which gives special stiffness and rigidity to the floors of the vessels, and reduces the liability to damage in grounding and docking. Special docking keels have been provided, these last being a great safeguard against undue strains when the ship is taking

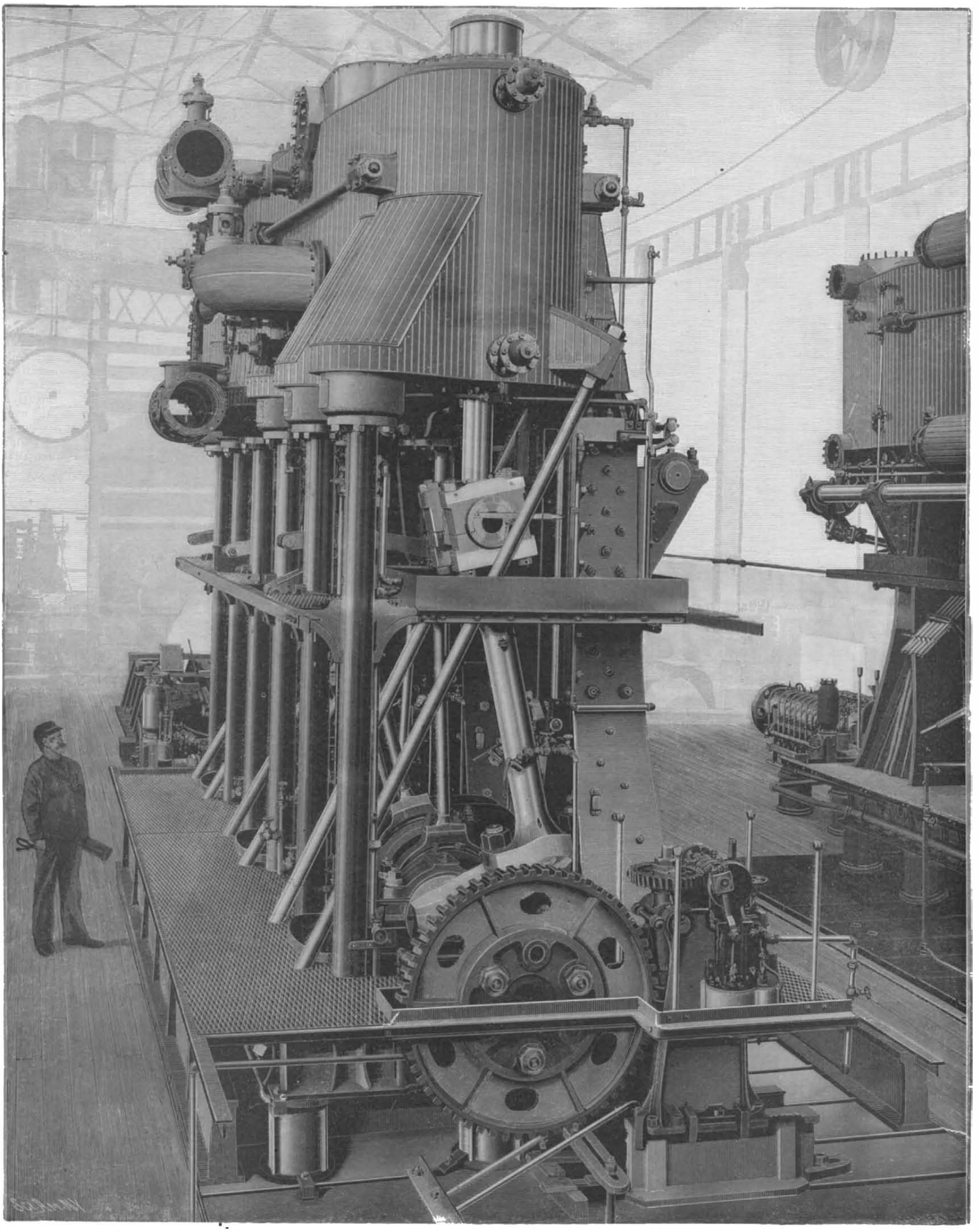


Displacement, 11,653 tons. **Speed,** 17.2 knots. **Bunker Capacity,** 1,310 tons. **Armor:** Belt, 16½ inches to 4 inches; turrets, 14 inches; barbettes, 15 inches; deck, flat 2¾ inches, slopes 3 inches to 4 inches. **Batteries:** Four 13-inch B. L., fourteen 6-inch R. F., sixteen 6 pounders, six 1-pounders, four Colts, two 3-inch field guns. **Torpedo Tubes,** 4. **Complement,** 590.

FIRST-CLASS BATTLESHIP "WISCONSIN." ALSO "ALABAMA" AND "ILLINOIS."

the keel blocks. The coal bunkers have been designed with a view to easy stowage and accessibility for firing, and at the same time they have been placed so as to give a maximum protection to the boilers. A new departure also is the method of placing the boilers, which are arranged fore and aft, the two smokestacks being placed side by side, a conspicuously novel feature in ships of the United States navy.

In these vessels we see a return to the high freeboard which distinguishes the "Iowa" from the "Kentucky" and the ships of the "Oregon" class, whose freeboard is not more than 12 or 13 feet. In the "Alabama" class a spar deck extends from the bow throughout two-thirds of the length of the vessel, terminating just forward of the after barbette. This feature not only gives better sea-going qualities, but the forward guns are given an extra command of about 7 feet, and a considerable increase of berthing space is provided for the crew. The hull is protected at the waterline by a belt of Harveyized armor with a maximum thickness of 16½ inches, the belt extending from 3 feet 6 inches above to 4 feet below the normal low waterline. The maximum thickness is maintained throughout the entire length of the engine and boiler spaces. Above the belt, over the same spaces, is a 2¾-inch protective deck. Forward and aft of the barbettes the protective deck slopes toward the sides of the vessel and has a thickness of 3 inches toward the bow and 4 inches toward the stern of the ship. Where the protective deck is sloped at the sides there are cofferdams, 3 feet in width, packed with corn-pith cellulose, which has the property of swelling and forming a water-tight packing should the waterline be penetrated by a shell. Forward and aft of the main armor belt are transverse bulkheads of 12-inch armor. From the wake of the forward barbette to the bow



ENGINES OF THE "WISCONSIN."

Cylinders: HIGH PRESSURE, 33⅓ inches; INTERMEDIATE, 51 inches; LOW PRESSURE, 78 inches; STROKE, 48 inches. **Working Pressure,** 180 pounds to the square inch. **Horse Power,** 12,609.

the waterline armor is reduced in thickness, tapering to 4 inches as a minimum. From the top of the main armor belt to the main deck protection is afforded by a belt of 5½-inch armor which turns in to meet the barbette, thus forming a completely inclosed citadel. Immediately inside the 5½-inch armor are worked cofferdams, 3 feet in width by 3 feet in height, which are packed with corn-pith cellulose. Above the 5½-inch belt is another continuous wall of 5½-inch armor which extends from the main deck to the spar deck. This wall also terminates in forward and after transverse bulkheads. Within the protected citadel thus formed is mounted on the main deck a broadside battery of eight 6-inch 40-caliber rapid-fire guns, and on the same deck forward toward the bow, two 6-inch guns are mounted in two sponsons protected by 6 inches of armor. It should be mentioned that 1½-inch splinter bulkheads are worked in between each pair of 6-inch guns in the central battery. On the spar deck above the broadside battery are four additional 6-inch guns, with an arc of fire from abeam to dead-ahead and dead-astern. These guns also have 6 inches of armor protection. The armor on the conning tower is 10 inches in thickness and the tube which connects the conning tower with the central station below the protective deck has walls 7 inches in thickness.

The main battery consists of four 13-inch guns, mounted in turrets, one forward and one aft, protected by 15 inches of armor, which is increased to 17 inches on the port plates. These port plates, by the way, are another innovation, being inclined sharply to the rear with a view to deflecting projectiles and presenting a greater horizontal thickness to penetration should the projectiles "bite." The barbettes are protected by 15 inches of armor. The turrets, like those on the "Kentucky," are oval, the oval form being adopted to reduce unnecessary space at the side of the guns and provide extra room behind them for handling and loading. Another good feature of these turrets is that the center of gravity of the rotating parts lies in the axis of rotation, and the turret, being thus exactly balanced, can be turned without difficulty, even when the ship is rolling or has a heavy list. The forward 13-inch guns have a fine command, their axis being 26½ feet above the normal load waterline. The after turret swings just above the main deck and has a command of 19 feet. Each turret has three sighting hoods. The one in the center is occupied by the officer whose duty it is to keep the guns pointed at the target, and who is simply concerned with the turning in a lateral direction. The hoods on either side are occupied by the gun pointers, who attend to the elevation and depression of the guns. The secondary battery is made up of sixteen 6-pounder, rapid-fire guns, six 1-pounder, four Colts, and two 3-inch rapid-fire field guns for the use of landing parties. The vessels are provided with four long Whitehead torpedoes, which are discharged from the berth deck, the torpedo tubes being located behind the protection of the 5½-inch side armor. Although the contract speed for these vessels was only 16 knots, they each did over a knot better, the trial speed of the "Alabama" being 17.1 knots, that of the "Wisconsin" 17.17 knots, while the "Illinois" made 17.45 knots. As may be seen from the accompanying photographic view of the "Wisconsin," these vessels present a fine, seaworthy appearance, and while somewhat behind the battleships of their date in speed, they are superior in armament and protection.

ENGINES OF THE BATTLESHIP "WISCONSIN."

Although the work of the Bureau of Steam Engineering of the navy does not figure so prominently in the illustrated journals of the country as that of the Bureau of Construction, which is responsible for the design of the hulls of our warships, it is no less important, and to its efficiency we owe much of our naval prestige. Witness the feat of the "Oregon" in steaming 14,000 miles to the theater of war, and almost on the day of her arrival giving successful chase to a 20-knot cruiser and bringing her to, with a shell from her forward gun. Well-designed and well-built motive power and efficient engine room service did far more to win the victories of the late war than they have ever received credit for.

The engines of the "Wisconsin," herewith illustrated, were designed by the Bureau and built by the Union Iron Works, San Francisco. There are two sets of engines, rights and lefts, placed in separate watertight compartments, separated by a longitudinal bulkhead. They are of the vertical, inverted-cylinder, direct-acting, triple-expansion type. The high-pressure cylinder is 33½ inches, the intermediate 51 inches, the low-pressure cylinder 78 inches in diameter, the common stroke of all pistons being 48 inches. The maximum indicated horse power of the two sets as developed on trial was 12,609.

Tre framing consists of special forged and bolted-up columns for the back, and forged steel, turned columns for the front side. The forged column consists of two forged, scrap-iron, plate sides, with fianges for securing the column to the bed-plate, forged solid with the sides, as are also the fianges for securing the columns to the cylinder bottoms. Between these two sides is secured the casting that forms the main guides, which extends clear through from the front to the back of the columns and forms a rigid connection between the two sides. Below the guides the sides separate and form an inverted Y-frame, and here a plate is worked in between the two legs forming a strong intercostal. The construction provides a frame of great rigidity, which does not weigh any more than the cast steel frames, and provides a greater certainty of absolutely reliable material. It has given complete satisfaction in the engines of the "Olympia" and the "Oregon," and has been readily accepted by the Bureau of Steam Engineering in place of the type called for in the original specifications of these engines. The crank shaft is made in three sections, which are reversible and interchangeable. The crank pins are 14¾ inches in diameter and 17 inches long, and the crank webs are each 16¼ inches wide by 10 inches thick. A 7½-inch hole is bored axially through each shaft and crank pin. The thrust shafts are 14 inches in diameter with 9-inch axial holes. Each shaft has 11 thrust collars, 2 inches wide, placed 3½ inches apart, the outside diameter of the collars being 21½ inches. The propeller shafts are 14¾ inches in diameter, with a 9¾-inch axial hole bored throughout their length, the hole being tapered in the after section, where it passes through the propeller hub. All of the crank line and propeller shafting is of hollow, forged steel, of very high quality. The reversing gear is of the straight-push type, controlled by a hydraulic controlling cylinder and differential valve gear, and a hand pump is attached to the hydraulic end of the reversing engines for operating by hand. The air pumps, which are of the single-acting, vertical type, with inverted steam cylinders, are independent of the main engines. There are two air pumps for the set, which balance each other.

A special feature of the condensers for these engines is the fact that the shells are made of steel plate, the water ends being of bronze. This is a feature that may be considered as somewhat experimental, and the result of using steel for the shell will be watched by marine engineers with considerable interest. The main circulating pumps which supply the condensers with cooling water are of the centrifugal type. There are two of them, one being placed in each engine room. When they are used as emergency pumps on the bilge of the ship they will have a capacity of 12,000 gallons per minute each. Each engine room is also fitted with an auxiliary condenser with its air and circulating pumps, fire and bilge pumps, main and auxiliary feed pumps, and hydraulic steering pumps in duplicate.

The screw propellers are of manganese bronze and are three-bladed, the pitch being variable from 16 feet 6 inches to 18 feet 6 inches, the designed pitch being 17 feet 6 inches. The diameter of the propellers is 15 feet 6 inches. The starboard propeller is right, and the port propeller left-handed. Each blade is firmly bolted to the boss by tap bolts of rolled manganese or Tobin bronze, secured by lock plates. An interesting feature is that the hubs and plates for these propellers have been tinned, this being done for the purpose of maintaining a better surface on the propellers, and also with a view to mitigating, to a certain extent, any galvanic action which may arise between the propellers and the adjacent steel structural material. The ship carries eight single-ended steel boilers placed in four compartments, two boilers in each compartment. Each boiler has a mean outside diameter of 15 feet 6½ inches, and an outside length of 10 feet. They have a total grate surface of 685 square feet and a total heating surface of 21,200 square feet; the boiler pressure is 180 pounds to the square inch.

"MAINE" CLASS—FIRST-CLASS BATTLESHIP "MAINE."

The "Maine" class of battleships, which includes the "Maine," "Missouri" and "Ohio," was authorized May 4, 1898. The first plans drawn up for these vessels were almost identical to those of the preceding ("Alabama") class. The announcement of their contract speed, which was set down at 16 knots, aroused a storm of criticism, on the ground that this was at least 2 knots less than the average speed of foreign battleships at that time under construction, and the agitation resulted in a decision to enlarge the ships, and give them a speed of 18 knots an hour. The amended designs were a great improvement over those which they superseded. While the hulls are similar to the "Alabama" type, they are refined by the addition of 20 feet amidships, this lengthening being made to accommodate the increased motive power necessary to give the additional 2 knots speed. It also admitted of the addition of two more 6-inch guns to the broadside battery. The improvement of the "Maine" over the "Alabama" was not confined, however, to speed. The developments in armor manufacture, during the few years preceding the construction of the vessel, due to the introduction of the Krupp process of face-hardening, had enabled our Naval Constructors to secure the same amount of protection with considerably less thickness of armor, the weight thus saved being distributed judiciously among the other offensive and defensive elements of the design. Moreover, the Bureau of Ordnance had succeeded in making a highly satisfactory form of all-nitrocellulose smokeless powder, and it had brought out an entirely new set of guns suitable to the new powder, of great length and high velocity, which, piece for piece, were vastly more powerful and effective than the earlier weapons. Water-tube boilers had also been developed to a point at which the Bureau of Engineering felt justified in adopting them exclusively in the "Maine" class. One advantage of the reduction of weights, due to the use of improved materials of construction, is seen in the increase of the maximum coal-bunker capacity from 1,355 tons in the "Alabama" to 2,000 tons in the "Maine."

The hull is constructed with the usual double-bottom, elaborately subdivided, and controlled by powerful pumps. The upper, or spar-deck, as in the "Alabama," extends aft to the after barbette, the freeboard forward being 19 feet and aft 11 feet. The vessels have the seaworthy qualities and handsome appearance of the "Alabama" class, but the effect is enhanced by the greater length and by the arrangement of the funnels on the longitudinal axis of the vessel instead of transversely, as in the preceding class. The waterline belt has a thickness amidships of 11 inches at the top and 7½ inches at the bottom. It extends from abaft of the after barbette forward to the stem, decreasing to 4 inches in thickness as a minimum at the bow. The protective deck is 2¾ inches on the fiat above the engine and machinery spaces and slopes with a thickness of 3 inches to the bow, and aft, with a thickness of 4 inches, to the stern. Diagonal bulkheads of heavy armor will extend athwartship from the main armor belt at each barbette. Resting upon the main belt and its bulkheads is another wall of armor, 6 inches in thickness, which will be about 16 feet in height and will extend unbroken, from the main belt to the upper spar deck. This wall of armor will prevent the entrance of explosive shell beneath the central, 6-inch rapid-fire battery, and will form a complete wall in front and around this battery.

The turrets containing the four 12-inch guns will have a thickness of 11 inches and 12 inches on the port plates. Forward, in the bow, the two sponsons which carry, each, a 6-inch gun, will be protected by 6 inches of armor, and the same thickness will protect each pair of guns on the upper deck amidships. All of this armor will be face-hardened by the Krupp process and, ton for ton, its resisting power will be from 40 to 50 per cent greater than that of the untreated plates, with which our ships of twelve or fifteen years ago were protected.

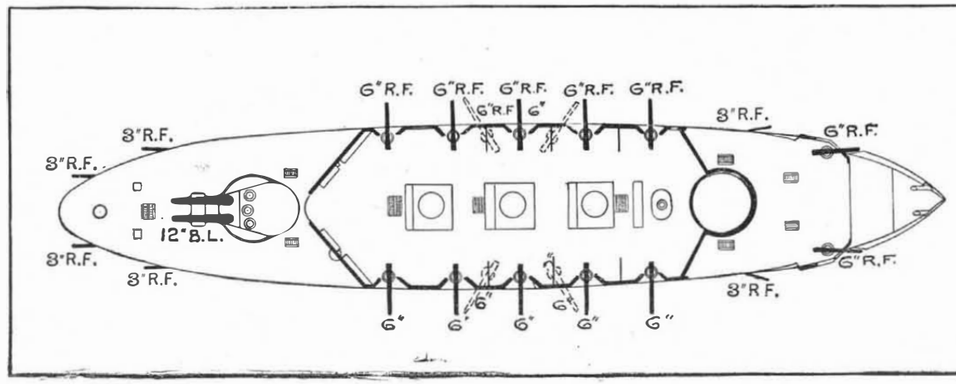
The main armament will consist of four of the new smokeless powder, 40-caliber, 12-inch guns, and sixteen 6-inch smokeless powder 50-caliber guns. This 12-inch gun has developed on trial a muzzle energy just under 48,000 foot tons, or nearly double the energy of the 12-inch guns of the "Iowa," when using brown powder during the war. The 6-inch gun has shown a velocity of over 3,000 feet per second and a muzzle energy of over 6,000 foot tons, or about double that of the 6-inch guns firing brown powder with which our vessels were equipped during the Spanish War.

Other novel features in the "Maine" class are the fitting of under-water torpedo tubes, the advantage of which over above-water torpedo tubes in respect of safety from explosion by the enemy's shell-fire is obvious. The lessons of the war, as shown in the destruction by confiagration of Cervera's fleet, are exemplified in the fact that wood is used very sparingly throughout the vessel. With the exceptions of the main deck outside the superstructure, the upper deck and the bridges, decks will be covered with linoleum, rubber tiling, wire mats or cement, and such wood as is used will be fully fireproofed. Wherever it is possible light metal will be used for gangways, bridges and all fixtures, except such as can be readily thrown overboard when going into battle. Another noteworthy feature in these vessels is that electricity will constitute the motive power of many of the auxiliary engines. It will be used to run the ventilating blowers, hoist the ammunition, to turn and control the turrets, besides furnishing light throughout the vessel and providing current for four searchlights and a double set of Ardois night signals.

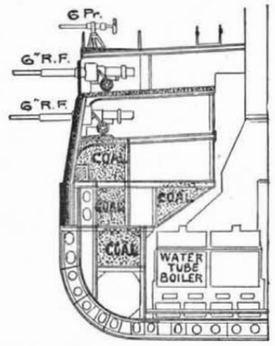
"VIRGINIA" CLASS—FIRST CLASS BATTLESHIP "GEORGIA."

The five great battleships of the "Virginia" class form by far the largest and most important addition ever made to the United States navy. Never before have we built so many armored ships of one class, and never a vessel of the great displacement of 14,948 tons. The "Maine" of 12,300 tons is a big ship; but the "Georgia" will be larger by 2,648 tons. The story of the increase is shown in the accompanying table.

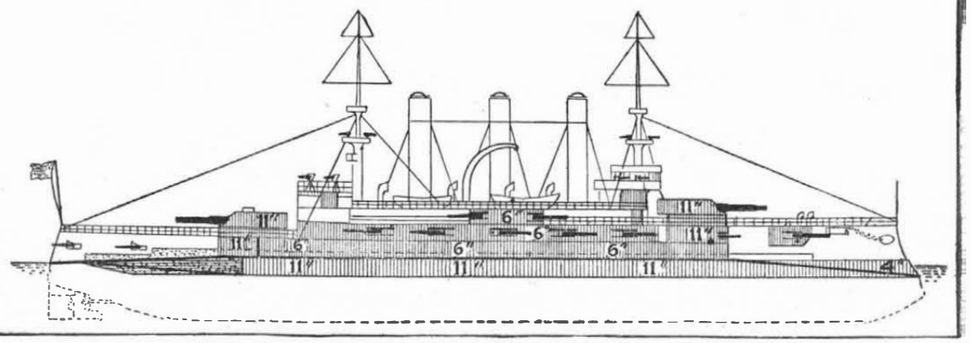
The vessels of the "Virginia" class will be known as the "Georgia," "Nebraska," "New Jersey," "Rhode Island" and "Virginia." The first three were author-



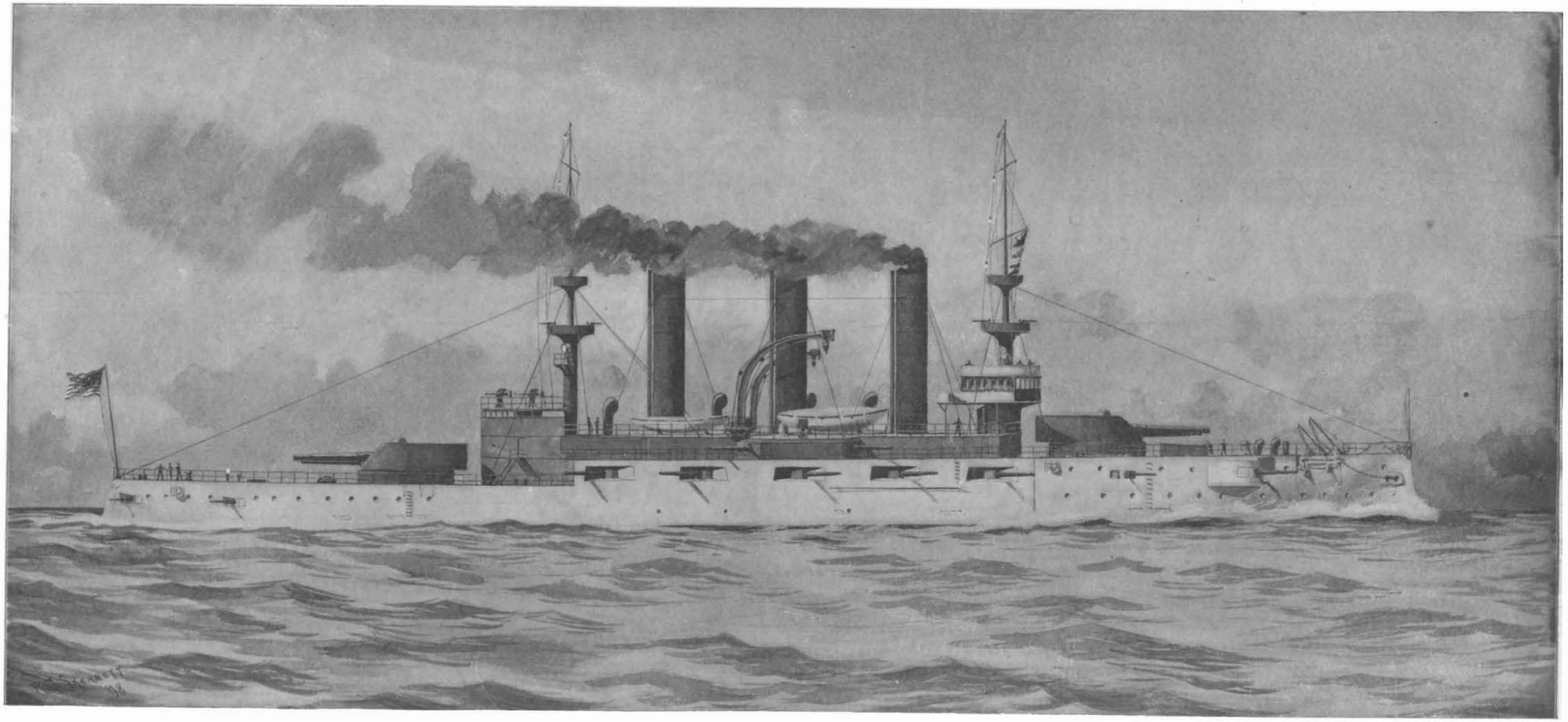
Plan of Main Deck.



Midship Section, Showing Protection of Boilers by Double Bottom, Side Armor and Coal Bunkers.



Gun and Armor Plan. "Maine" Class.



FIRST-CLASS BATTLESHIP "MAINE." ALSO "MISSOURI" AND "OHIO."

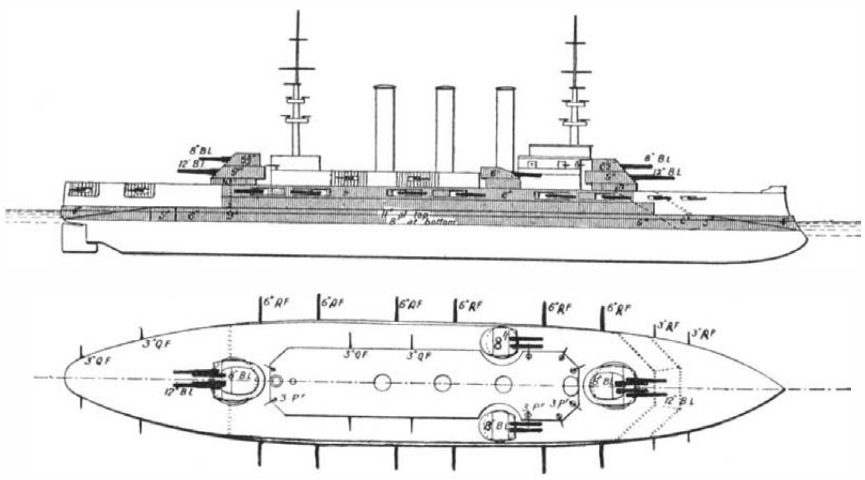
Displacement, 12,300 tons. **Speed,** 18 knots. **Bunker Capacity,** 2,000 tons. **Armor** (Krupp): Belt, 11 inches to 4 inches; turrets, 12 inches to 11 inches; barbettes, 12 inches; deck, flat, 2¾ inches, slopes, 3 inches to 4 inches. **Armament:** Four 12-inch 40-caliber, sixteen 6-inch 50-caliber R. F., six 3-inch R. F., eight 6-pounders, six 1-pounders, two Colts, two 3-inch field guns. **Torpedo Tubes,** 2 submerged. **Complement,** 551.

Battleship.	Authorized.	Length.	Displacement.
Texas.....	1886	301 feet.	6,315 tons.
Oregon..	1890	348 "	10,288 "
Kentucky.....	1895	368 "	11,540 "
Maine.....	1898	388 "	12,300 "
Georgia.....	1901	435 "	14,948 "

ized on March 3, 1899; the last two on June 7, 1900. The accepted design, as shown in the accompanying illustration, was only arrived at after a long controversy in the Naval Board on Construction, which was prompted by the revival of the question of the superposed turret. As first designed, the "Georgia," "Nebraska" and "New Jersey" were to be of 14,650 tons displacement, and their main armament was to consist of four 12-inch and eight 8-inch breech-loading rifles, and twelve 6-inch rapid-fire guns, besides a dozen of the new 3-inch rapid-fire pieces, the 8-inch guns to be carried in four separate turrets as in the "Oregon." In the following year, when the battleships "Virginia" and "Rhode Island" were authorized, the acceptance and gunnery trials of the superposed turrets on the "Kearsarge" had made such a favorable impression that an agitation was started in favor of reviving this form of turret on the two new ships. The suggestion was opposed by the Board of Construction, the same arguments being used as in the discussion over the "Kentucky" and "Kearsarge." Ultimately, as a compromise, it was decided to build three ships with and two without the superposed turrets, and a few months later the board, for the sake of uniformity, declared in favor of building the whole five ships with superposed turrets.

Of course, the most striking novelty in these magnificent ships is their great size. As compared with the "Maine" class the length has gone up from 388 feet to 435 feet; the beam from 72 feet 2½ inches to 76 feet 2½ inches; while the normal draft is 3 inches greater, or 23 feet 9 inches, as against 23 feet 6 inches. Great size has distinct advantages in the way of seaworthiness, a stable gun platform, and a wider margin of flotation when the waterline is being pierced in a close action. The greater displacement of the "Georgia" has been judiciously distributed among guns, armor, and motive power. She is the fastest, best protected and most powerfully armed ship in the United States navy, and the most powerful in any navy. A great improvement over the "Maine" class will be seen in the uniform freeboard of 20 feet from bow to stern. Apart from the military advantage gained in the added command of the guns of the main battery aft, there will be a net gain in accommodations, which will contribute greatly to the comfort and healthfulness of both officers and crew. None of them will be shut up behind blank walls of heavy armor, and lighted only by artificial means, the living spaces all having air ports and direct access to sunlight. The added freeboard aft, too, will make the ships more weatherly in a following sea.

The hull will be protected by an 8-foot belt reaching from stem to stern, which will extend 5 feet below and 3 feet above the waterline at normal draught. From the top to the waterline the belt will be 11 inches through, and thence to the lower edge it will taper to 8 inches. These dimensions will be maintained throughout the engine and boiler room spaces for a distance of 192 feet. Forward and abaft of this the belt will taper in thickness to a minimum of 4 inches at bow and stern. Above the main belt, for a distance of 245 feet amidships, i. e., throughout the position of the main broadside rapid-fire battery of 6-inch guns, the sides will be reinforced by armor of a uniform thickness of 6 inches. This armor will reach all the way up to the main deck, and it will be joined to the barbettes of the 12-inch turrets by athwartship armor of 6 inches in thickness aft, and by inclined armor of like thickness forward, yielding, in this latter case, the added protection of glacis against the head-on raking fire of an enemy. The after athwartship armor is vertical. There will be a curved protective deck from bow to stern, which will be 1½ inches thick on the flat and 3 inches thick on the slopes. A cellulose belt 3 feet in thickness will be worked continuously from bow to stern along the sides above the protective deck. The obturating material will be the well-known corn-pith cellulose. Wood will be used very sparingly, and, where indispensable and not exposed either to the weather or under water, will be fire-proofed. Light metal bulkheads will supplant the usual wooden partitions in the living spaces; some of the furniture will be of pressed metal; the chart-house will be of bronze; and all of the decks under cover will be laid with linoleum. To guard against the overheating of the magazines, there will be a 4-inch air space around them in addition to a coating of some non-conducting material, while certain of the magazines are to be arranged so that they may be chilled by compressed air from the refrigerating plant.

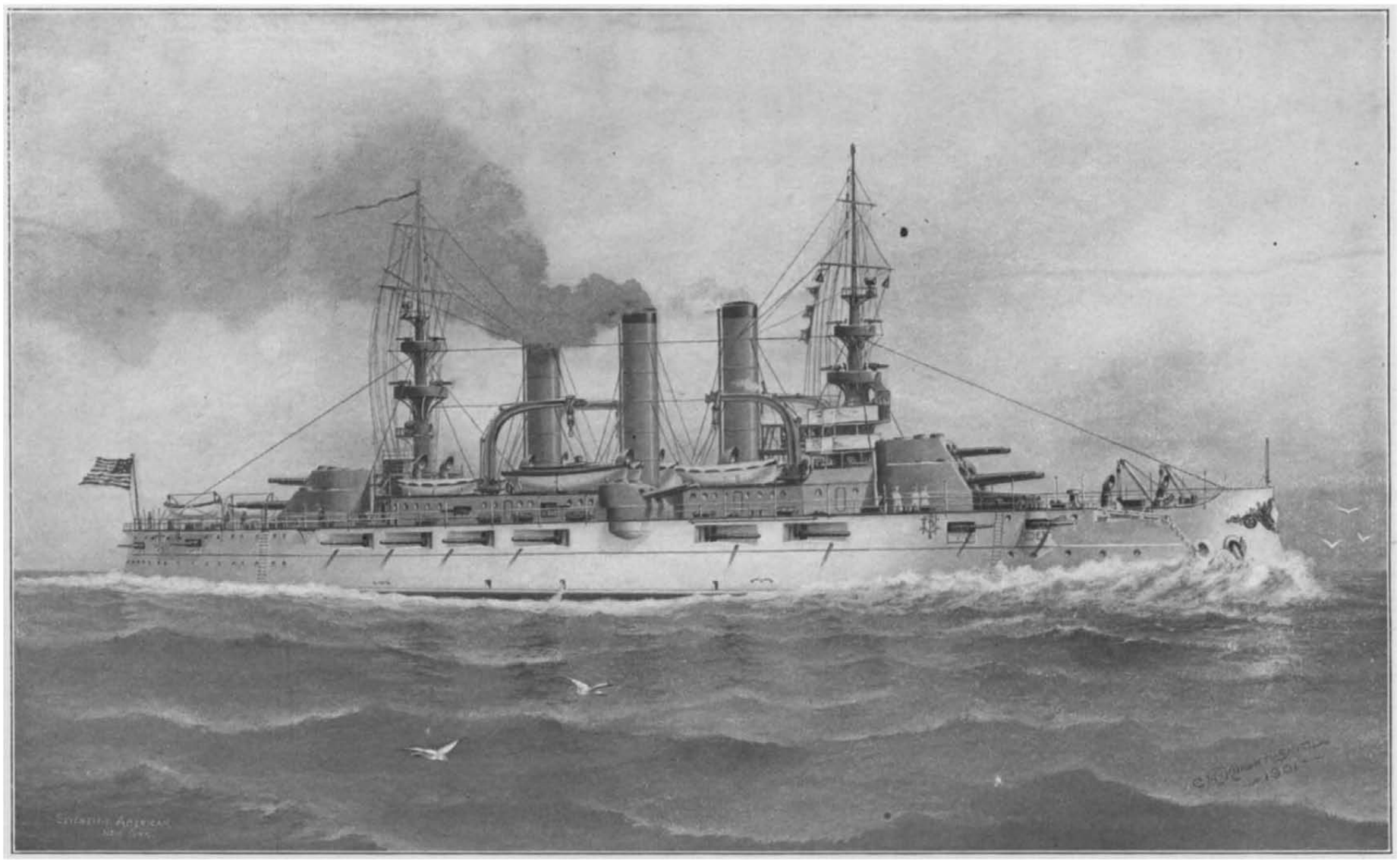


Gun and Armor Plan; "Georgia" Class. "Georgia," Nebraska," "New Jersey," "Rhode Island," "Virginia."

The fighting powers of the vessels will be centered in the main battery of four 12-inch and eight 8-inch breech-loading rifles, the main rapid-fire battery of twelve 6-inch breech-loading rifles, the secondary rapid-fire battery of twelve 14-pounders and a dozen 3-pounders, and the auxiliary battery of eight 1-pounders, two field pieces, two machine guns, and a half dozen 0.3 automatic guns. All the heavy guns will be of the new smokeless-powder, long-caliber type.

The four 12-inch rifles will be mounted in two elliptical, balanced turrets 10 inches thick except for the slanting port plates, which will be an inch heavier. These guns will fire through arcs of 270 degrees. Four of the 8-inch guns will be superposed upon these turrets, fixed to move in unison, and they will be sheltered by walls of 6-inch armor increased half an inch on the slanting face plates. The four remaining 8-inch guns will be mounted amidships, two on each side, on the main deck, and will be housed in independent turrets similar to those placed above the 12-inch guns. These 8-inch rifles will have arcs of fire of 180 degrees, ranging from dead ahead to dead astern. This arrangement of the 12 and 8-inch guns gives a bow and a stern fire of six 8's and two 12's, and a broadside of six 8's and four 12's.

The 6-inch guns are arranged in broadside. Each gun, of which there are six on each broadside, has an arc of fire of 110 degrees, and the ports are so arranged that the guns can be turned inboard within the side line, the two forward pairs swinging forward, and the other eight guns swinging aft, the recesses being



Displacement, 14,948 tons. **Speed,** 19 knots. **Bunker Capacity,** 1,900 tons. **Armor:** Belt, 11 inches to 4 inches; turrets, 11 to 10 inches and 6½ to 6 inches; barbettes, 10 inches and 6 inches; deck, flat, 1½ inch, slope, 3 inches. **Armament:** Four 12-inch 40-caliber B. L.; eight 8-inch 45-caliber B. L.; twelve 6-inch 50-caliber R. F.; twelve 3-inch R. F.; twelve 3-pounders; eight 1-pounders; two 3-inch field guns; six automatic guns; two machine guns. **Torpedo Tubes,** 2 submerged. **Complement,** 705.

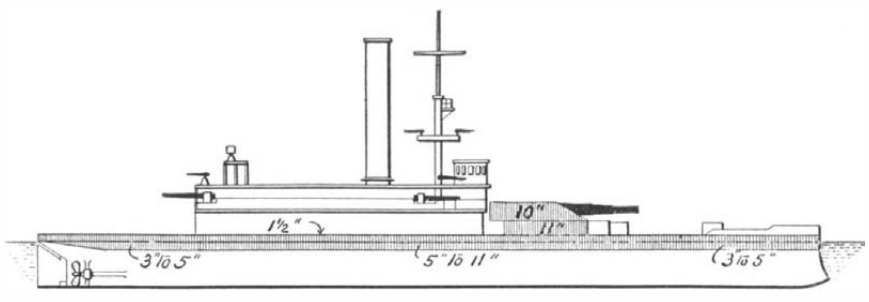
FIRST-CLASS BATTLESHIP "GEORGIA."

long enough to bring the muzzle of the gun almost flush with the side of the ship. This arrangement does away with the inconvenience of dismounting the guns to avoid obstructions or to guard them against the stress of heavy weather. Each of these guns is sheltered behind a heavy port shield, and there is a splinter bulkhead of 2½-inch nickel steel between each gun and its neighbor on either side. The twelve 14-pounders, sheltered by local armor of 2-inch steel and by shields, are to be mounted eight on the gun deck well forward and aft, and four up in the superstructure on the main deck, aft of the amidship 8-inch turrets. The twelve 3-pounders are to be mounted on the bridges and on the superstructure deck, while the 1-pounders, automatic and otherwise, and the Gatlings, are to be placed in the tops and in the boats. The submerged torpedo-tubes, of which there are two, are to be placed one on each side, well forward, and the operator is to control his tube from an armored station on the deck above, sufficiently sheltered to be proof against 6-pounder fire.

The main engines will be of the four-cylinder triple-expansion type, driving twin screws, capable of developing 19,000 indicated horse power, and designed to drive the ship at 19 knots. The steam pressure will be 250 pounds, and the cylinders will be: H. P. 35 inches, I. P. 57 inches, and two L. P. each of 66 inches dia. by 4 feet stroke. Number of revolutions a minute, 120. There will be twenty-four boilers of the straight water-tube type, placed in six water-tight compartments. They will have quite 1,280 square feet of grate and 55,000 square feet of heating surface. The air pressure in the ash-pits will not exceed one inch of water. Each ship will be fitted as a flagship and accommodations will be provided for 37 officers and 668 seamen and marines; a total complement of 705 persons.

The stem is carried well forward below the water and formed into a powerful ram. The maximum beam is 50 feet; and the draught upon the normal displacement of 3,235 tons is 12½ feet. Upon this displacement the ship carries, closely stowed in the bunkers, 400 tons of coal.

The hull is of steel, unsheathed, with an inner bottom reaching up to the armor shelf and ranging fore and aft throughout nearly the whole length of the ship. This intramural space is extensively subdivided into water-tight compartments, and, like the large, main compartments of the ship proper, it is under the control of a pumping plant of large capacity.



Gun and Armor Plan; "Arkansas" Class. "Arkansas," "Wyoming," "Connecticut," and "Florida."

The hull is protected by a continuous band of armor, extending from the main deck line down to a depth of 30 inches below the waterline amidships. This armor has a maximum thickness of 11 inches at the deck line throughout the region occupied by the engines, the boilers, and the magazines, tapering thence to the armor shelf well below water. Forward and abaft the "vital" space the armor is graduated by easy steps till it terminates at the bow and the stern in thicknesses of five inches. The protective deck, or more properly speaking the main deck, is composed of two thicknesses of ¾-inch plating, of which the upper course is of nickel steel. This is sufficient defense against the acute angle at which most plunging shots would have to strike.

A five-sided superstructure occupies the central portion of the main deck. In the lower half are quartered some of the officers, and there, too, is the galley, the armory, some wash rooms, and spare space for the housing of part of the crew if so desired. On the next deck above, i. e., the superstructure deck, is placed the major part of the rapid-fire portion of the battery. The hammock berthing is also in the superstructure on that deck, lending a very mild protection to the gun crews of some of the smaller pieces. On the bridge or uppermost deck are carried the chart-house, the boats, and all of the 6-pounder rifles. This and the deck just below, like the main deck, being exposed to the weather, are not fireproofed; but the berth deck, being under cover, is covered with linoleum placed right upon the fundamental plating. Wherever possible, woodwork is omitted and supplanted by light metal bulwarks, etc., but where wood is found needful for the sake of health and the saving of weight, it is carefully fireproofed.

The ship is propelled by twin screws driven by two triple-expansion engines, placed in one watertight compartment. These engines are of the vertical, inverted-cylinder, direct-acting type, each with a high-pressure cylinder of 17 inches, an intermediate-pressure cylinder of 26¼ inches, and a low-pressure cylinder of 40 inches, the stroke of all pistons being 2 feet. The collective indicated horse power of the propelling and the circulating pump engines will be 2,400 when the main engines are making in the neighborhood of 200 revolutions per minute. Steam is supplied at a working pressure of 250 pounds, by four water-tube boilers, having a total grate surface of quite 200 square feet, and a total heating surface of 8,800 square feet, and capable of supplying all the steam on shipboard when running at full power.

The vessel is lighted by electricity, while the turret mechanisms and all the ammunition hoists will be actuated by the same power. By the adoption of electricity so generally, the presence of long passages of heating steam pipes is obviated, and in this way alone a very considerable reduction of temperature will be effected under service conditions.

The main battery consists of two of the new 40-caliber 12-inch breech-loading rifles, and the secondary battery of four 4-inch rifles, while the auxiliary battery includes three 6-pounders and four automatic 1-pounders.

The 12-inch guns are mounted in a single barbette turret of the balanced type, having an inclined face with a pitch of 42 degrees. The armor for the turret and the barbette is 10 and 11 inches thick and treated by the Krupp process. The four 4-inch guns are mounted on the four principal corners of the superstructure deck, where they will command a wide field of fire. These guns are protected by shields. Three 6-pounders are mounted on the bridge deck, while the 1-pounders are placed on the hammock berthing, amidships, and up in the single top of the military mast. The 12-inch and the 4-inch guns are designed for smokeless powder, the first having a muzzle velocity of 2,800 feet per second and the latter of 2,900 feet per second, the respective muzzle energies being 46,246 and 1,870 foot-tons.

The ship will carry two searchlights, one forward on the mast and the other upon a stand at the after end of the bridge deck. Every modern facility will add to the equipment and finish of the vessel, and ample quarters and bathing facilities will make life reasonably comfortable for the complement of a captain, six other officers, and 130 enlisted men.

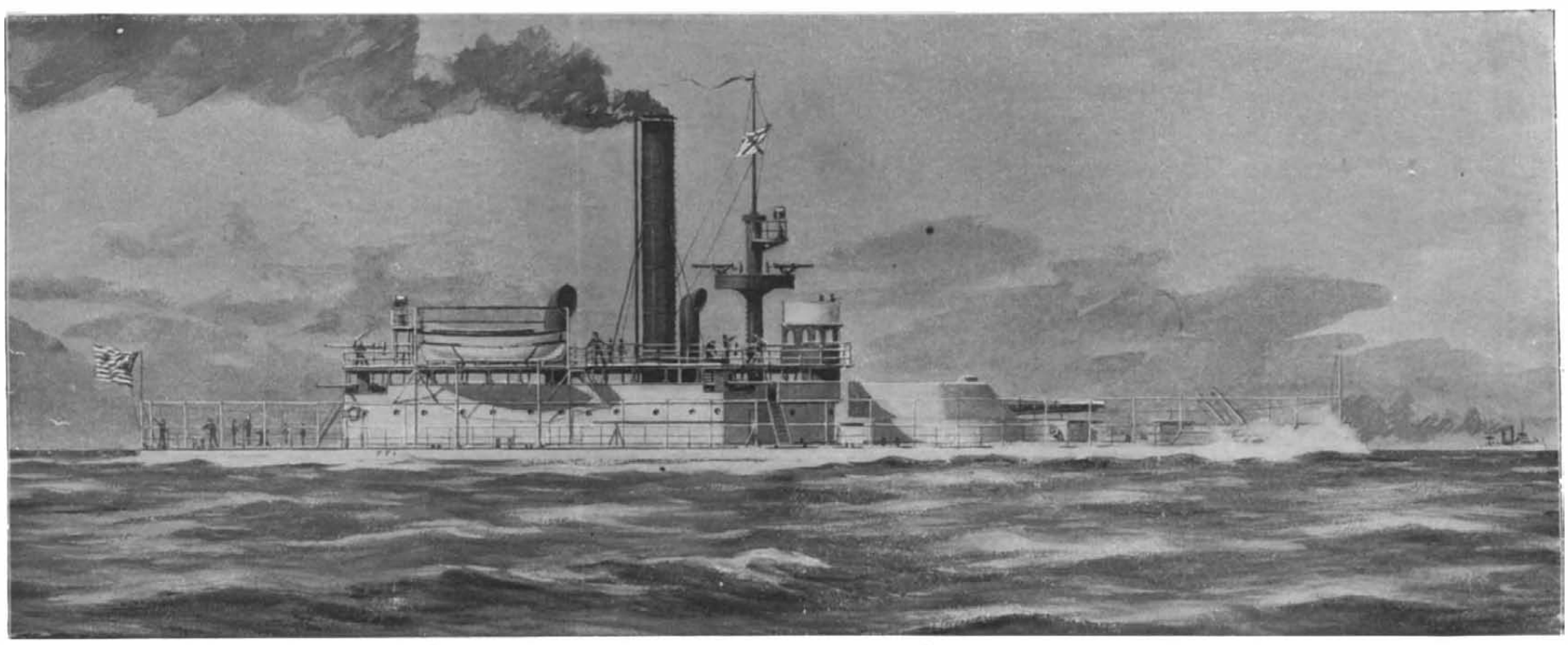
Monitors.

"ARKANSAS" CLASS—THE MONITOR "ARKANSAS."

It is safe to say that the four monitors "Arkansas," "Wyoming," "Connecticut" and "Florida," which are now under construction for the United States navy, are the last monitors that will be built for our own or any other navy. In the light of modern developments the type is discredited. Indeed, these four will owe their existence to panic legislation during the late war, due to the fear of bombardment entertained by some of the leading Atlantic cities. The monitor is purely a harbor-defense vessel, and would be practically useless, if not, as Sampson's operations off the northern coasts of Cuba and Porto Rico proved, a positive incumbrance in naval operations on the high seas.

The monitor lacks those prime qualities of a fighting ship—seaworthiness, steadiness as a gun platform, habitability, and mobility. As regards this last, one battleship, capable of going anywhere and casting loose her guns under any conditions, is worth a fleet of monitors, huddled within a mined and fort-defended harbor, into which an enemy's fleet will in all probability never be so rash as to force an entrance.

The "Arkansas" has a waterline length of 252 feet.



Displacement, 3,235 tons. **Speed,** 11.5 knots. **Bunker Capacity,** 400 tons. **Armor:** Belt, 11 inches; turrets, 10 inches; barbettes, 11 inches: deck, 1½ inch. **Armament:** Two 12-inch 40-caliber B. L.; four 4-inch R. F.; three 6-pounders; six 1-pounders two Colts. **Complement,** 137.

HARBOR-DEFENSE MONITOR "ARKANSAS."

These four vessels will be used to a large extent to meet the growing need of proper schools of instruction for the increasing ranks of the naval militia; and it is easy to see how successfully they meet the demand, by covering every practical branch of naval warfare, with the single exception of torpedo duty.

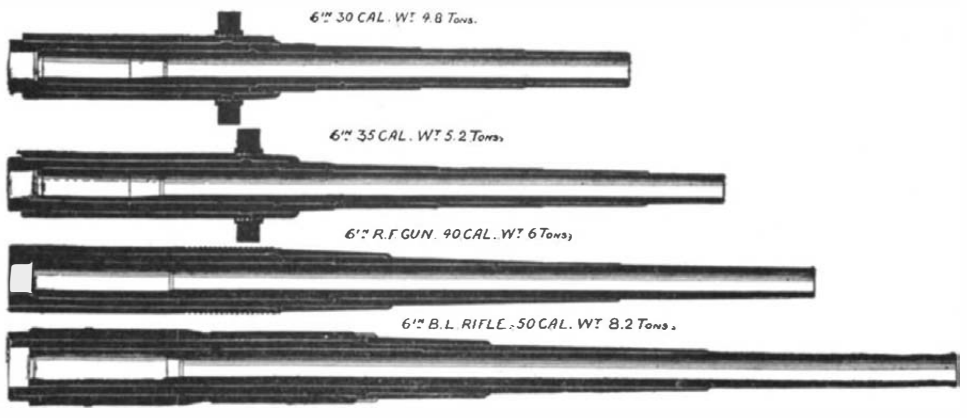
Guns and Armor.

LATEST TYPES OF NAVAL GUNS.

If it be considered that the striking energy of a ship, or her ability to deliver a maximum weight of projectiles against the enemy in a given time, is the supreme mark of her efficiency, then it must be admitted that the great development which has taken place since 1898 in our warships is due more than anything else to the remarkably powerful guns with which they are equipped.

There is no denying that the war caught us napping in the matter of smokeless powder; and had our struggle been against a first-class naval power, whose ships were armed with long-caliber smokeless-powder guns—well, to put it mildly, our repair bill would have been a heavy one. With a few exceptions our ships were armed with old-pattern, brown-powder guns, of low velocities and energies compared with the long-caliber smokeless-powder weapons with which our new warships are being equipped. The remarkable velocities obtained by projectiles in our new type of naval guns is due to the large powder chamber, big charge, slow combustion and sustained acceleration in the long bore of the gun, these combined elements enabling the new 6-inch gun, for instance, to deliver its 100-pound projectile with a muzzle velocity of 2,900 feet per second, as against a velocity of 2,000 feet per second in the old 30-caliber 6-inch gun, thereby more than doubling its energy.

There is no branch of the naval service in which a greater advance has been made in the past three years than in the Bureau of Ordnance, where the experimental work has been extremely successful. The starting point in the reconstruction of our naval ordnance was the powder; it was necessary to secure a smokeless powder that would give high ballistic results and at the same time would be perfectly stable. The Bureau has directed its attention with great success to the development of an all-guncotton powder, from which nitro-glycerine is completely excluded, and the last report of Rear-Admiral O'Neil states that this year's experience with the navy smokeless powder places it in a high position as a propellant, the results even exceeding those of the previous year. The accompanying table of the latest types of naval guns tells its own story, and we draw particular attention to the power of the new 12-inch rifle, which after a flight of 3,000 yards has sufficient remaining velocity to perforate 19.5 inches of Krupp armor. The table includes the new 7-inch gun, which is likely to take the place of the 6-inch gun in the broadside batteries of our future battleships. The 6-inch gun is unequal to the penetration of the 6-inch casemate armor of modern battleships at a range of 3,000 yards, whereas the new 7-inch piece can penetrate 8.3 inches of Krupp steel at that range and would, therefore, at least where the shot struck normal or approximately normal to the armor, have the intermediate guns of the enemy under control. We direct attention also to the diagram showing the development of the 6-inch gun from the 30-caliber brown-powder gun of 1883 to the 50-caliber piece mounted on the battleship "Maine" and class of 1901. To illustrate the enormous increase in power of our battleships due to the new guns, we offer a comparison of the total energy of fire of the "Oregon," as she was equipped during the war, with the total energy of fire of the new "Georgia" type now under construction. The "Georgia" is, of course, a larger vessel; but although the increase in displacement is only about 40 per cent, the total energy of five minutes' fire at the greatest practicable rate of firing aimed shots would be 2,765,830 foot-tons as against 819,456 foot-tons for the "Oregon," an increase of about 340 per cent. This enormous increase of total energy is not due so much to increase in rate of fire, as to the increase of muzzle energy, which energy in some cases, as will be seen from the accompanying table, is about double that of the same pieces as used in 1898.



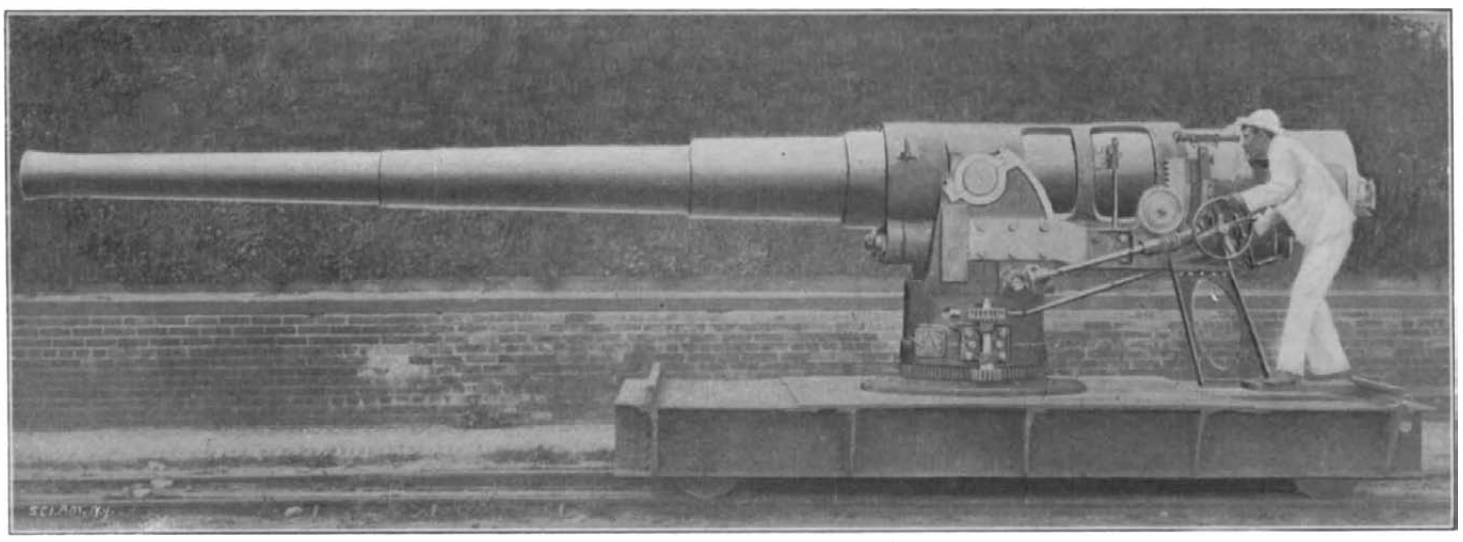
DEVELOPMENT OF 6-INCH GUN, 1883 TO 1901.

It will be noted that in spite of the great increase in length, there has been a simplification of the construction of the new type of guns. The 30-caliber gun, for instance, consisted of twelve separate pieces, whereas the new 50-caliber piece, although weighing nearly twice as much, contains only half a dozen separate pieces. The substitution of a long jacket and a few long hoops for the many short hoops of the 30-caliber gun not only cheapens construction, but adds greatly to the transverse strength of the piece.

It should be mentioned in connection with the table showing the ballistic powers of the guns that the velocities shown are the service or designed velocities. As a matter of fact, at the proving ground the new powder proved to be so excellent that higher velocities than these have been obtained with powder pressures lower than the 17 tons per square inch for which the guns were designed. Thus the 12-inch piece has given a muzzle velocity of 2,854 foot-seconds and corresponding energy of 47,944 foot-tons with a powder pressure of 16.5 tons to the inch. The 7-inch 45-caliber gun has given a muzzle velocity of 3,000 foot seconds with a chamber pressure of 17 tons. The 6-inch gun has shown 2,935 foot-seconds with a little over 16 tons pressure. The 5-inch gun has done even better, having delivered a 60-pound projectile with a muzzle velocity of 3,100 foot-

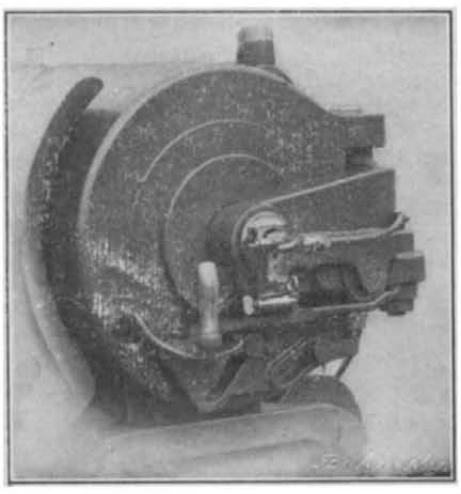
TABLE OF ELEMENTS OF LATEST TYPES OF NAVAL GUNS (MODELS OF 1899), GIVING PERFORATION OF FACE-HARDENED ARMOR, SERVICE VELOCITIES, AT RANGES UP TO 3,000 YARDS, WITH SMOKELESS POWDER, CAPPED AND UNCAPPED ARMOR-PIERCING PROJECTILES, AT NORMAL IMPACT.

Caliber of gun.	Weight in tons.	Length in caliber.	Approximate charge of smokeless powder for maximum velocity.	Weight of projectile.	Muzzle velocity.	Muzzle energy.	Perforation at muzzle. Krupp armor. Projectiles. Capped.	Perforation at muzzle. Krupp armor. Projectiles. Uncapped.	Remaining velocity at 1,000 yds.	Perforation at 1,000 yds. Krupp armor. Projectiles. Capped.	Perforation at 1,000 yds. Krupp armor. Projectiles. Uncapped.	Remaining velocity at 2,000 yds.	Perforation at 2,000 yds. Krupp armor. Projectiles. Capped.	Perforation at 2,000 yds. Krupp armor. Projectiles. Uncapped.	Remaining velocity at 3,000 yds.	Perforation at 3,000 yds. Krupp armor. Projectiles. Capped.	Perforation at 3,000 yds. Krupp armor. Projectiles. Uncapped.
			Lbs.	Lbs.	Ft.-secs.	Ft.-tons.											
3-in., Mark I..	0.87	50	5	13	2800	709	4.4	3.6	2130	3.1	.....	1620	.....	.....	....	.....	.....
4-in., Mark VII	2.56	50	15	32	2900	1870	6.4	5.6	2380	5.2	4.4	1955	4.	3.4	1605	3.2	.....
5-in., Mark V.	3.3	50	27	60	2900	3503	8.4	6.6	2460	6.7	5.6	2085	5.5	4.7	1770	4.6	4.6
6-in., Mark VI.	8.37	50	46	100	2900	5838	10.9	7.3	2525	8.8	6.8	2185	7.2	6.	1895	5.9	5.2
7-in., Mark I...	13.33	45	74	165	2900	9646	13.2	10.5	2580	11.4	8.9	2295	9.7	7.6	2040	8.3	6.5
8-in., Mark V..	18.	45	115	250	2800	13602	15.	12.1	2530	13.2	10.4	2290	11.7	9.1	2070	10.3	7.9
10-in., Mark II.	33.4	40	240	500	2800	27204	20.	17.1	2585	18.3	15.	2390	16.5	13.5	2210	15.	11.5
12-in., Mark III.	52.	40	385	850	2800	46246	25.	21.7	2620	23.	19.4	2450	21.2	17.9	2295	19.5	16.2

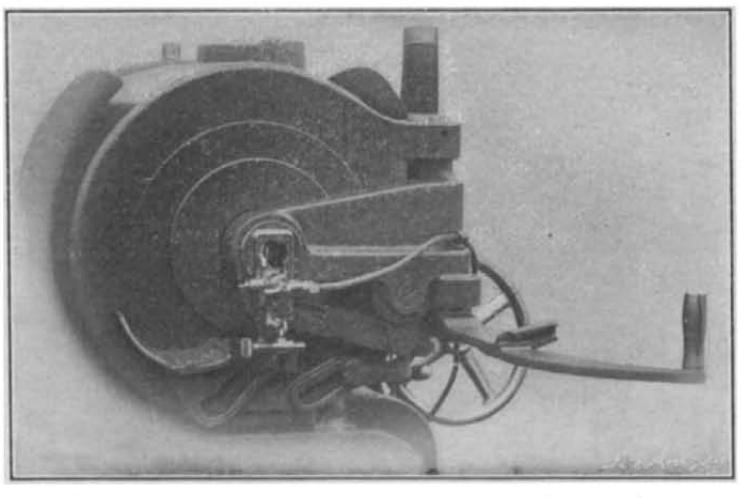


NEW NAVAL, 50-CALIBER, 6-INCH, RAPID-FIRE GUN.

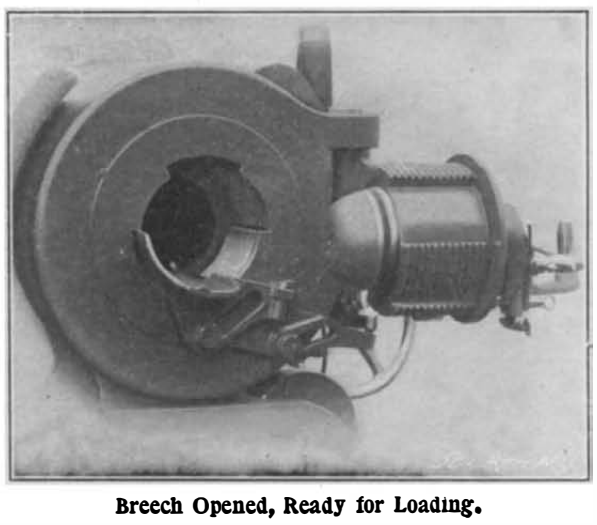
Weight, 8.2 tons. **Length,** 25 f et. **Muzzle Velocity,** 2,900 foot-seconds. **Muzzle Energy,** 5,838 foot-tons.



Breech Closed and Locked.



Breech-Plug Rotated Ready for Withdrawal.



Breech Opened, Ready for Loading.

BREECH MECHANISM OF NEW 6-INCH RAPID-FIRE GUN. SAME MECHANISM ON 5-INCH AND 7-INCH GUNS.

seconds and 17 tons pressure; while with a 50-pound projectile and a chamber pressure of 16.4 tons, the remarkable velocity of 3,380 foot-seconds was obtained. This is the piece that will form the main armament of the cruisers of the "Denver" class.

GUN-MOUNTS AND BREECH MECHANISMS.

The increased rate of fire of the new guns is chiefly due to the improved gun-mounts and breech mechanisms. In the first place, all guns recoil in a sleeve which carries the trunnions. Upon this sleeve are mounted the telescopic sights, and the man who traverses and elevates the gun, in the case of the large rapid-fire pieces, stands on a platform which is supported from this sleeve. He is thus able to keep the gun steadily upon the target, and is not affected by the recoil. His position, with his hands upon the traversing and elevating handwheels and his eye at the telescopic sights, is shown clearly in the photograph of the 6-inch gun. All guns from 3-inch up are fitted with the "Welin" patent breech-plug, the rights for which were purchased for several hundred thousand dollars from the Vickers-Maxim firm. The thread is cut in steps of varying radius—a device which reduces the amount of cutting away of the thread and also the depth of the plug and the distance it must travel before it is fully inserted.

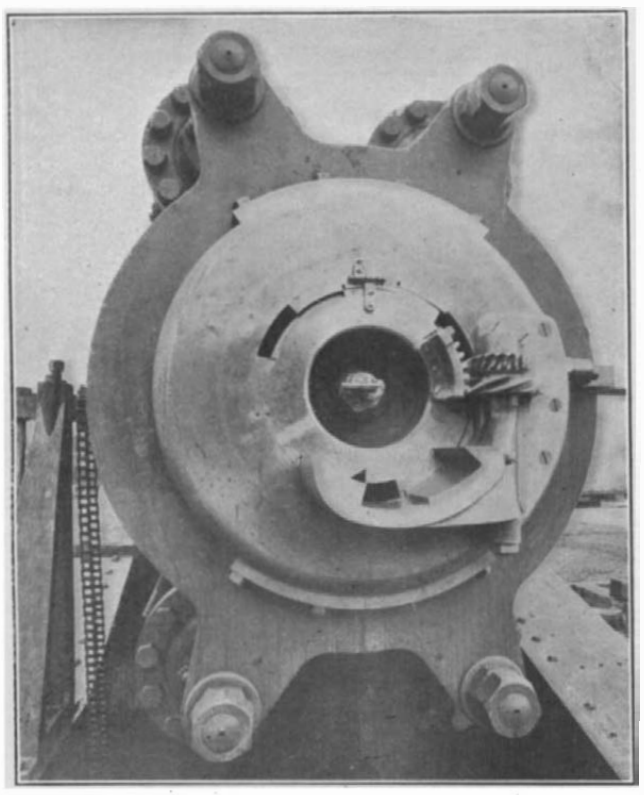
The 7-inch and all calibers below open the breech with a horizontal lever. One sweep of the lever unlocks the thread, withdraws the plug, and swings it clear of the breech, as shown in the illustration.

The 8-inch rifle and all calibers above this open with a crank, as the plug is too heavy and the swing is too great for opening with a lever. The time consumed in opening and closing the breech, however, is but a minute fraction of that required for the service of the gun; it is loading and pointing that take the most ime.

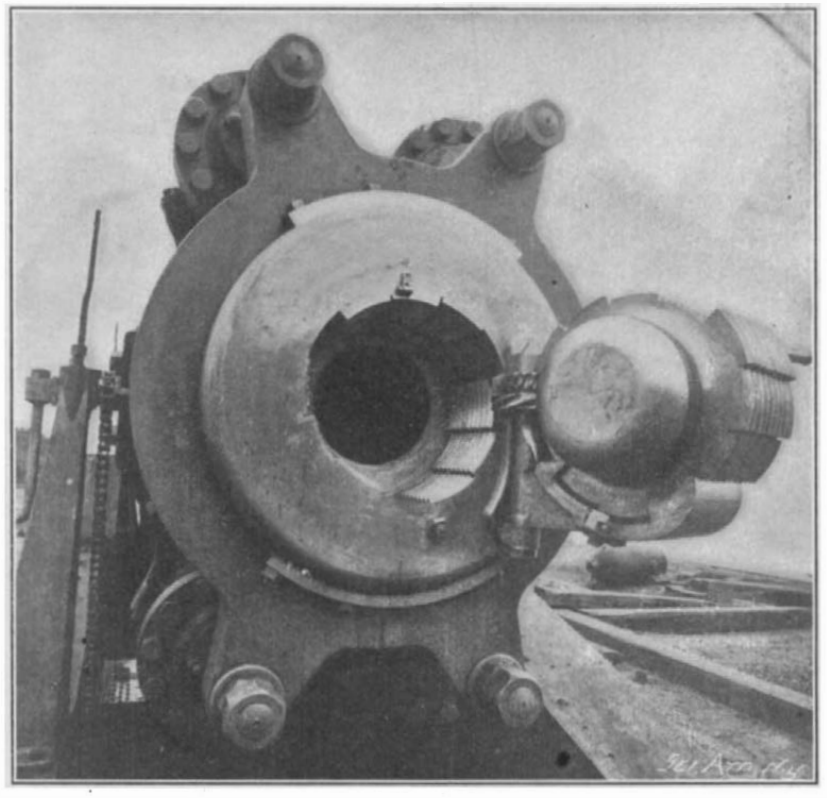
In the case of the 12-inch guns, the continued movement of the crank first rotates or unlocks the plug, which is followed by its withdrawal and the swinging round of the plug. It takes about 7½ turns of the crank to open or close the breech of a 12-inch gun, which can easily be performed in less than 5 seconds. The 8-inch gun breech is practically the same, but being lighter, can be handled more quickly.

The recoil of the 12-inch gun is taken up by four hydraulic cylinders placed symmetrically around the gun, but attached to the sleeve or non-recoiling part. A yoke on the rear end of the gun serves as an attachment for the piston rods, which work in the recoil cylinders, and recoil is checked by the escape from the pressure to the reverse side of the piston of the liquid contained in the cylinders. The escape orifices for the fluid are grooves cut in the walls of the cylinders, which are wide enough to give a full opening at the beginning of recoil, gradually contracting in area until the proper limit of recoil is reached, when the grooves come to a point and thus cut off any further flow of liquid. The recoil of the 12-inch guns for the "Maine" and class and for the monitors is 33 inches. Inside each recoil cylinder is a series of heavy triple-spiral springs (about one ton in weight), which are put in the cylinders under an initial tension sufficient to prevent the gun from moving when the ship rolls, or when the gun is elevated to its maximum limit. When recoil takes place these springs are further compressed, and they exert sufficient force to return the gun to the firing position as soon as recoil ceases. As the force exerted by these springs is great enough to return the gun to battery at extreme elevation, it follows that they have an excess of power to return the gun at level, and hence it would run out with great violence, probably injuring the mount, were it not that a hydraulic buffer, or counter-recoil check, is fitted in the front end of each cylinder, which gradually brings the gun to rest as it runs out.

The 8, 7, 6, 5, 4 and 3-inch guns all recoil in an oscillating sleeve. The piston rods are attached to the rear end of the gun by a yoke, and the recoil cylinders contain the counter-recoil springs. The recoil of the 8-inch gun is 24 inches, of the 7-inch 21 inches, of the 6-inch 15 inches, and of the 5-inch 11½ inches. None of the new guns above 4 inches in caliber uses the brass cartridge case, but the powder is put up in bags. The guns of and above 7 inches in caliber have the charge in two sections, as one section would be too heavy and too large to handle conveniently. In turret guns of large caliber the elevating, training, hoisting ammunition, and loading are all done by machinery operated by electric power. Guns of and below 7 inches in caliber are handworked. They are mounted on pedestal mounts, turn on ball bearings, and are balanced in their sleeves. Hence they can be elevated or depressed with great ease. In the case of the 6 and 7-inch guns, the gun-pointer stands on a platform attached to and turning with the gun. All guns above 3 inches in caliber are fitted with telescopic sights, also with open day and night sights and with electric and percussion firing gear.



Breech of New 12-Inch Rifle Closed.



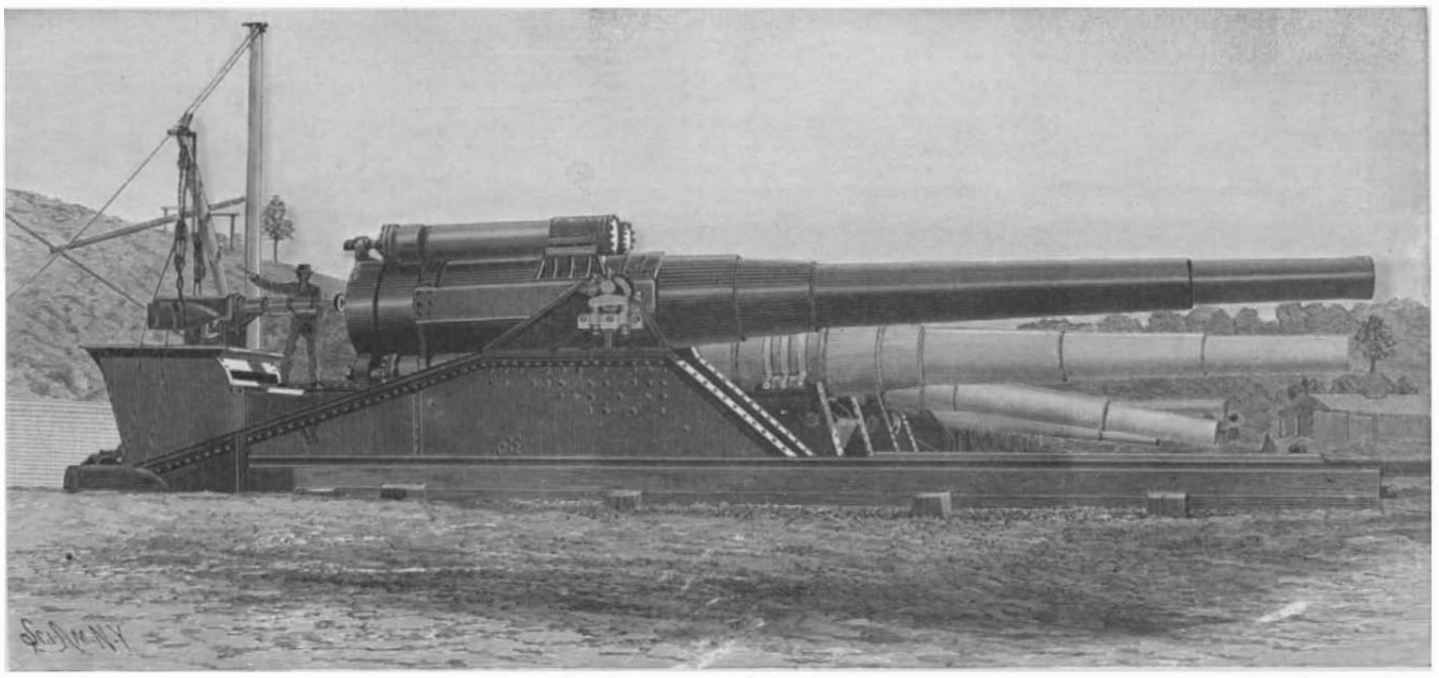
Breech of 12-Inch Rifle Open.

COMPARISON OF TOTAL ENERGY OF FIRE IN FIVE MINUTES OF BATTLESHIPS OREGON (IN 1898) AND GEORGIA

Oregon in 1898.				Georgia.			
Gun.	Muzzle Energy of Gun.	*Rate of Fire per Minute.	Muzzle Energy in Five Minutes.	Gun.	Muzzle Energy of Gun.	*Rate of Fire per Minute.	Muzzle Energy in Five Minutes.
4 13-inch.	33 627 foot-tons	0.4	269,016 foot-tons	4 12-inch.	46,246 foot-tons	0.66	610,447 foot-tons
8 8-inch.	8,011 "	1.0	320,440 "	8 8-inch.	13,602 "	1.2	652,896 "
4 6-inch.	2,990 "	2.0	119,600 "	12 6-inch.	5,838 "	3.5	1,225,980 "
20 6-pounders.	138 "	8.0	110,400 "	12 3-inch.	709 "	6.5	276,510 "
Total energy all guns in five minutes.....			819,456 "	Total energy all guns in five minutes...			2,765,833 "

*This is the *practicable* number of *carefully aimed* shots that could be fired per minute for a few minutes, as given by Rear-Admiral O'Neil, Chief of the Bureau of Ordnance.

It may be well to add a word of explanation, just here, on the question of rapidity of fire. The rates of fire given in the accompanying comparison of the "Oregon" and the "Georgia" will, doubtless, appear to some of our readers to be very low; but they must remember that these are *practicable* and not *ideal* rates of fire. Lieut. Meigs, ordnance officer of the Bethlehem Steel Works, in his recent address before the Society of Naval Architects in New York, quoted approvingly a record recently made by an English ship of 8 shots from a 6-inch gun in one minute, all of which struck a target 15 feet high, at a range of 1,500 yards. Here, the conditions were doubtless ideal, the ammunition being probably piled ready close at hand. The 3.5 rounds per minute, given in the table, represents actual conditions, in which the ammunition is being brought, round by round, from the magazines, and all the death and destruction of a sea-fight is present. Even 3.5 rounds per minute could be maintained for a few minutes only, since the heating up of the gun, alone, would necessitate a rest.



Maximum Muzzle Velocity, on trial, 2854 foot-seconds. **Muzzle Energy,** 47,994 foot-tons. **Foot-Tons Energy per Ton Weight of Gun,** 893. **Chamber Pressure,** 16.5 tons per square inch.

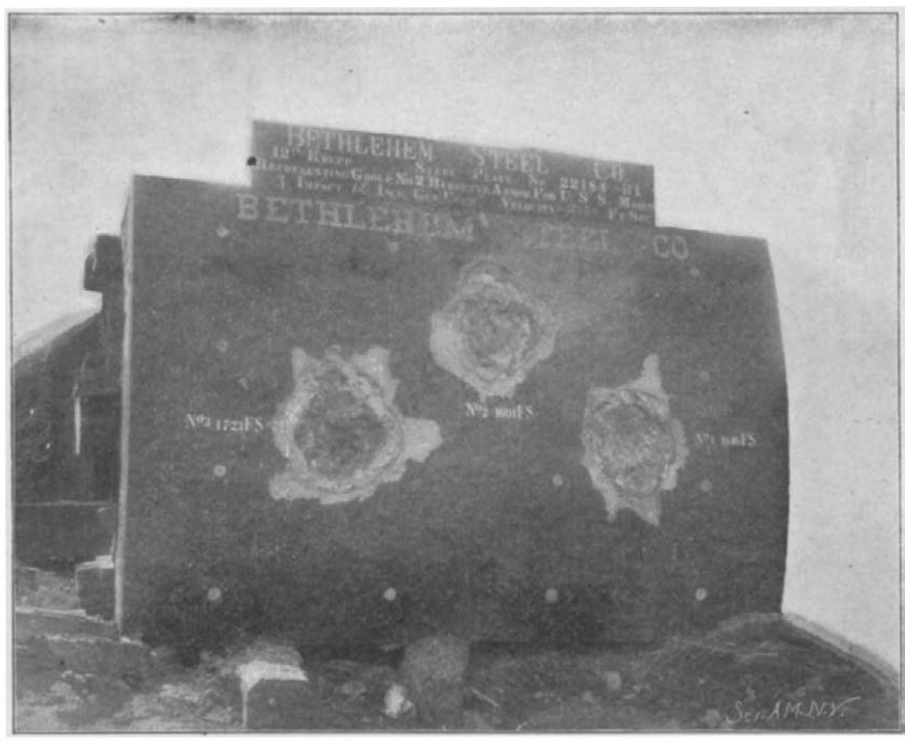
NEW NAVAL 12-INCH, 40-CALIBER GUN.

ARMOR PLATE AND HIGH-EXPLOSIVE SHELLS.

Commencing with the "Maine" class, all future battleships of the United States navy will be protected with face-hardened armor treated by the Krupp process, which produces a plate about as much superior to the Harveyized plate as that was to the armor which it superseded. The objects sought in the manufacture of armor plate are great toughness of body to resist cracking and breaking up of the plate, and extreme hardness of the face, with the object of smashing the projectile before it can effect penetration. In the Harveyized plate great toughness is secured by using a certain percentage of nickel in making up the composition of the steel. This toughness is further secured by a very thorough furnace and mill treatment. Face-hardening is done by placing the plate, face upward, in a furnace, covering it with a layer of crushed bone and other carbonaceous material, and exposing it for the proper length of time to a predetermined temperature. The face of the plate takes up a large percentage of carbon, and after tempering with cold water becomes extremely hard. The Krupp process is similar in principle. Nickel is used in making up the composition, and the steel after being taken from the furnace is subjected in the fluid state to enormous pressure in a hydraulic press, which squeezes out the gas and various impurities. The compressed ingot is heated and forged into plate in a 14,000-ton hydraulic press, and then undergoes various processes of annealing to take out initial strains. The face-hardening is done in a furnace where gas is substituted for the carbonaceous material of the earlier process. By this method the face-hardening is carried into the plate about twice as deeply as in the Harvey process.

We present two photographs showing the Proving Ground tests of two plates, representing armor for the new battleships "Maine" and "Missouri." The 12-inch Carnegie plate for the "Missouri" was attacked by one Carpenter and two Wheeler uncapped shells, with striking velocities of 1,675, 1,669, and 1,664 feet per second. In each case the shells broke up after penetrating from 3½ to 4⅜ inches only. The plate in each case was dished only one-eighth of an inch, and no further damage was done than the flaking of the face-hardened surface. No cracks whatever were developed in the plate. In the case of the Bethlehem 12-inch plate for the "Maine," one Carpenter and two Wheeler uncapped shells were used; the striking velocities were 1,616, 1,692, and 1,723 feet per second. The shells broke up after penetrating 6½, 4½, and 4½ inches without developing any cracks in the plate, the only injury beyond the penetration being a flaking of the surface and a slight dishing of the plate in the first round to the extent of a quarter of an inch. The foregoing results indicate that the side, barbette, and turret armor of our latest battleships will be secure against the 12-inch shells of the enemy, except at close range.

12-Inch Kruppized Armor Plate Representing Armor for the "Missouri," After Attack by Three 12-Inch Shells. Projectiles Smashed on Plate. Penetration, 4⅜ Inches, 4¼ Inches, and 3½ Inches.



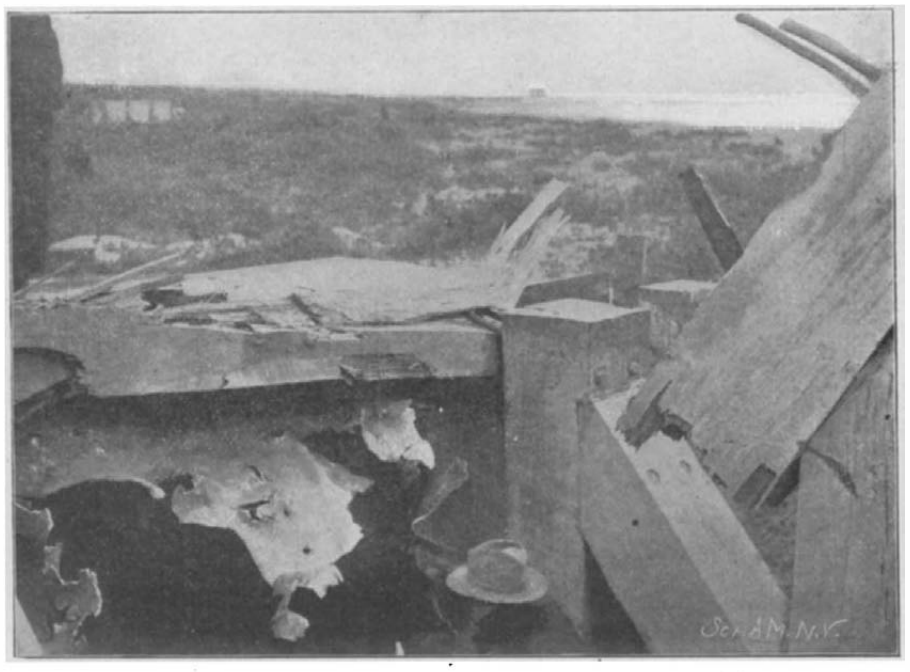
12-Inch Kruppized Armor Plate, Representing Armor for the "Maine," After Attack by Three 12-Inch Shells. Projectiles Smashed on Plate. Penetration, 6½ Inches, 4½ Inches, and 4½ Inches.

OUR POWERS OF DEFENSE.

The complete wrecking of the finest and heaviest modern armor plate by high-explosive shells, as shown in the accompanying illustrations, was the culmination of a very thorough investigation carried out by the Army Board of Ordnance at Sandy Hook, in the search for a high-explosive shell-filler that would meet all the ideal conditions as to safety, certainty, fragmentation and destructive effects. From the first appearance of high explosives artillerists have recognized how greatly they would increase the destructiveness of shell-fire, if they could be used as a shell-filler and rendered sufficiently insensitive to shock to be carried through armor plate and burst by a suitable time fuse in the interior of a fort or a battleship. The desiderata in such a high explosive are: It should be reasonably safe in manufacture; it must withstand the shock of discharge from the gun and the shock of impact when the shell struck and was passing through armor plate; it must be uniformly and completely detonated by a suitable fuse; it must possess the elements of stability—that is to say, it must not decompose under test, it must be non-hygroscopic, and it must not attack the metal of the projectiles and fuses. Lastly, it must not be attended with danger in loading into shells, and the explosive should be readily manufactured, and in large quantities, at a reasonable cost. Among the high explosives tested were black musket powder, the Rendrock Company's No. 400 explosive, picric acid, wet guncotton pellets, maximite, and explosive "D." Of these, the last two fulfilled in every particular the conditions laid down. Their exact composition is, of course, a secret; but it is known that maximite is a picric acid compound consisting mainly of a picrate. Its products of combustion are almost entirely gaseous, and as the heat developed on detonation is very great it possesses, as the result of its high gravity, an unusually high explosive value. "Dunnite," the other explosive is the invention of Capt. Dunn, of the army, and in its qualities and action it is very similar to maximite.

The plate which is shown in the accompanying illustration so completely smashed to pieces was one of two identical plates built under an appropriation by Congress, which was granted for the purpose of testing the regular 12-inch gun, firing service projectiles, against an 18-inch gun which was built especially for throwing the Gathmann, guncotton, torpedo shell. The Gathmann idea is to deliver a large amount of high explosive against the outside of a battleship, under the expectation that the detonation of the charge on impact will result in the bursting in of a large section of the ship's side. The Gathmann test plate and the armor service projectile plate were backed up with steel framing representing a section of the side of the battleship "Iowa." In these tests three of the Gathmann shells, each containing about one-quarter of a ton of wet guncotton, cracked the plate from top to bottom, but otherwise did it no material injury. The plate with its backing, however, was driven 8 feet into the sand backing, and the whole mass was swung around 8 feet to the left of its original position. However, in view of the great striking energy of 52,000 foot-tons of the 1,800-pound

An 11½-inch Kruppized Plate After Attack by Three of Our 12-Inch Armor-Piercing High-Explosive Projectiles. Plate and Backing Completely Wrecked.



Rear View of Same Target, Showing Complete Destruction Wrought by 12-Inch Armor-Piercing Shot Loaded with 20 Pounds of the New Government High-Explosive.

OUR POWERS OF ATTACK.

Gathmann shell, it was considered that the results on the plate itself were very inadequate. In the test of the service armor-piercing projectiles three rounds were fired, the first two being with armor-piercing shot filled respectively with 20 pounds of maximite and 20 pounds of dunnite, the last being an armor-piercing shell filled with 60 pounds of maximite. The projectiles burst as they were passing through the plate, which was completely broken up, and the flying fragments of plate and shells tore the steel backing literally to shreds, cut to pieces the heavy oak struts at the rear, and blew away several hundred tons of the sand backing.

As far as we know, large-caliber, high-explosive shells have never before been carried through heavy armor. Had this been done, it could scarcely have been kept a secret, and would surely have become known to the world at large. It is, therefore, evident on comparing the upper with the lower pair of photographs that, while our heaviest armor is impervious to attack at ordinary ranges by 12-inch shells, we are in the possession of a high-explosive shell which can penetrate and burst behind the best armor employed in foreign navies.

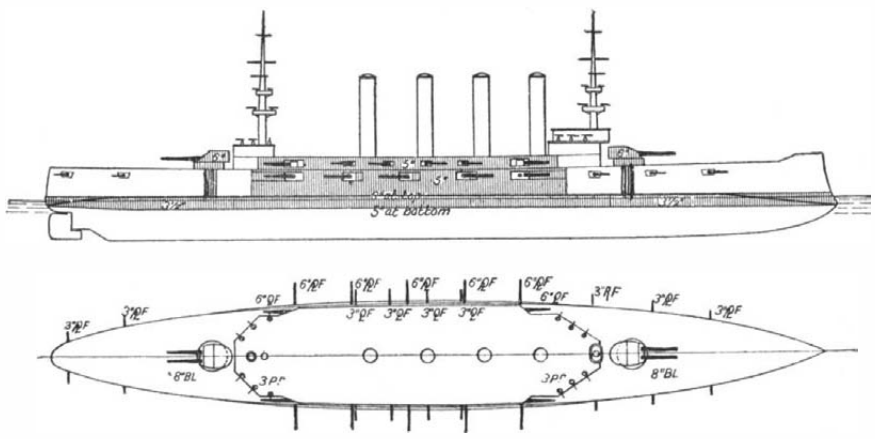
Armored Cruisers.

ARMORED CRUISERS OF THE "MARYLAND" CLASS—"CALIFORNIA."

The development of the cruiser during the past few years has been in two widely divergent directions. On the one hand we have the large armored cruiser of from 12,000 to 14,000 tons displacement, with a complete waterline belt; and well-protected positions for a main battery of two or four heavy 8, 9 or 10-inch guns, and full broadside or casemate armor for a numerous battery of broadside rapid-fire guns. On the other hand, we see the protected cruiser tending to lower speed, less protection and lighter battery. The line of division between the battleship and the armored cruiser, furthermore, is becoming less distinct; and the six magnificent ships of the "Maryland" class will be so well armored and protected that they would not hesitate to take their place in line of battle against second-class battleships, while their large coal capacity and high speed will enable them to fulfill all the requirements of the first-class cruiser.

The six fine vessels of the "California" class will be 502 feet long, or longer by 90 feet than the next largest ships in our navy; and they will be but little shorter on the waterline than ocean liners like the "St. Paul" and "New York."

The fighting positions and the "vitals" will all of them be sheltered behind walls of Kruppized steel, and the arrangement of armor protection will be as follows: First, a waterline belt 7 feet 6 inches wide extending from bow to stern, which carries its maximum thickness 4½ feet from the top down, whence it tapers to the armor ledge. For a distance of 244 feet amidships, the belt will have a maximum thickness of 6 inches and a minimum of 5; thence to the bow and to the stern the belt will have a uniform thickness, top and bottom, of 3½ inches. For a distance of 232 feet amidships, above the waterline belt and up to the main deck, the sides will be reinforced by 5-inch armor; transverse bulkheads, turning inboard at the ends of this side armor, will complete the central casemate, housing the ten 6-inch guns. These transverse bulkheads will be 4 inches thick. The protective deck will be continuous from bow to stern; on the flat it will be 1½ inch thick and on the slopes 4 inches thick. Above this protective deck, a cellulose belt 3 feet thick will be worked along the sides from one end of the ship to the other. It is required that the water-line armor belt be so placed that at least a foot of it will be out of water at deepest load draft.



Gun and Armor Plan; "California" Armored Cruiser Class. "California," "Colorado," "Maryland," "Pennsylvania," "South Dakota," "West Virginia."

The armament will consist of: A main battery of four 45-caliber, 8-inch, breech-loading rifles and fourteen 50-caliber, 6-inch, rapid-fire guns; and a secondary battery of eighteen 14-pounders, twelve 3-pounders, eight 1-pounders, two 3-inch field guns, two machine guns, and a half a dozen small-caliber pieces for boat service. There will be two submerged torpedo-tubes, to be placed on the broadsides pretty well forward. The 8-inch guns are to be mounted in two balanced elliptical turrets on the main deck forward and aft of the superstructure. These turrets will be generally 6 inches thick with slanting faces ½ inch thicker. The turrets are to be controlled electrically, and are to fire through arcs of 270 degrees. The rate of ammunition supply is one complete round of powder and projectile to each electric hoist every fifty seconds.

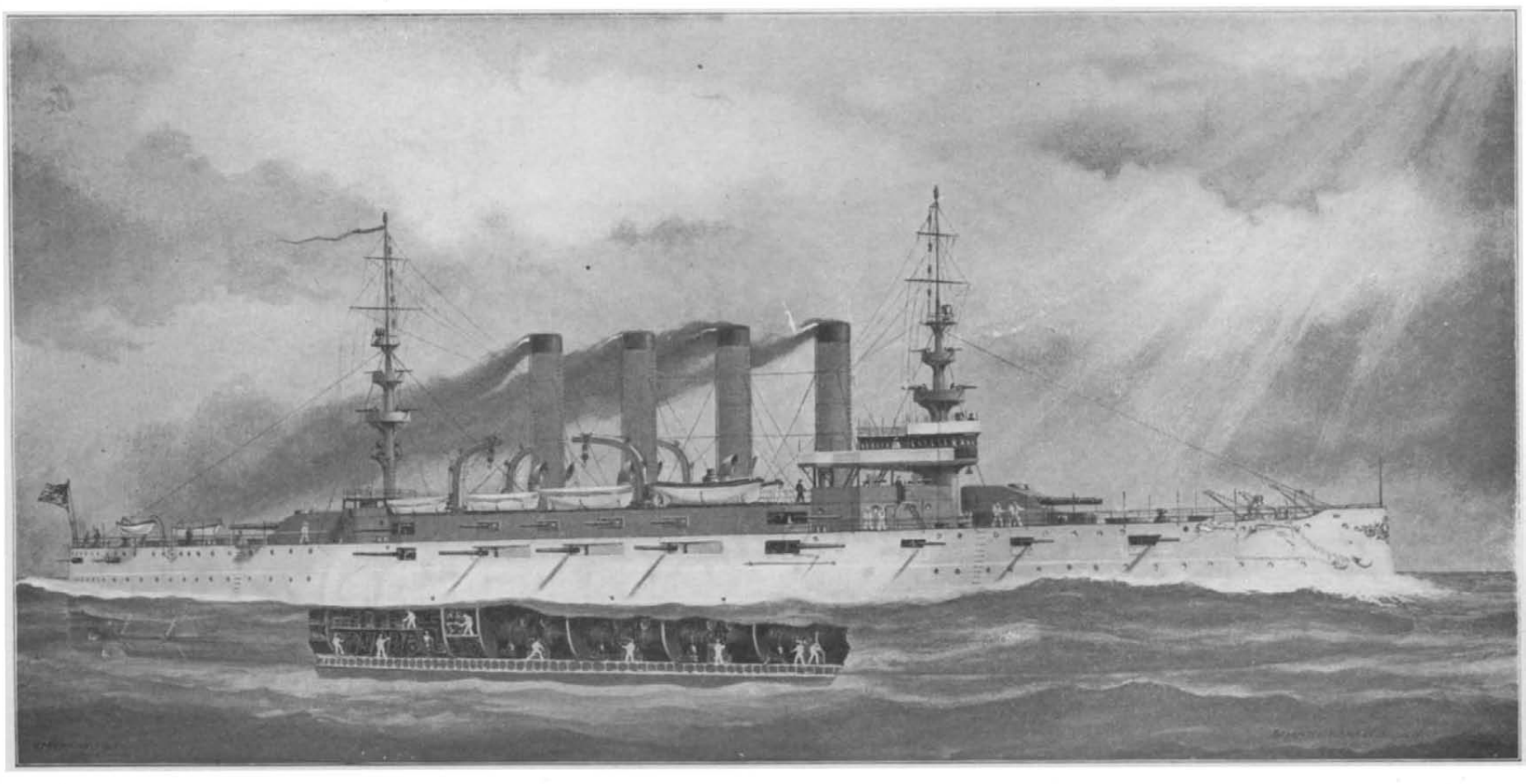
The four 6-inch guns mounted on the main deck are to be placed in sponsons at the four main corners of the superstructure, and are to fire through arcs of 145 degrees—the forward ones from dead ahead aft, and the after ones from dead astern forward. These guns are protected by 5-inch armor. The ten other 6-inch guns, five on each broadside, are to be placed amidships on the gun deck—the forward ones firing dead ahead, while all the other guns on each side will have arcs of fire of 110 degrees, and will be arranged to house within the side line. These guns will be separated by 2¼-inch splinter bulkheads. The ammunition hoists will be run by electricity, and are to supply each 6-inch gun with three complete rounds every minute. The 14-pounders will be mounted on the gun deck and up in the superstructure, three forward and two aft of the 6-inch battery on each side, and four on each broadside between the 6-inch guns up in the superstructure. The 3-pounders are to be mounted on the superstructure deck and on the bridges, while most of the 1-pounders are to fill the military tops. Each 14-pounder is to be supplied six rounds a minute, while the 3-pounders are to have ten.

The firing stations for the torpedoes will be sheltered from the reach of 6-pounders and lighter pieces, and are to be located above the torpedo tubes. The conning-tower, located at the fore end of the superstructure, will be of steel 9 inches thick, and the signal tower, located at the after end of the superstructure, will be of steel 5 inches thick. The pilot house will be of bronze. All magazines are to be carefully insulated, and certain of them are to be chilled by the refrigerating plant. All are also to be easily susceptible of instant flooding.

The ships will be driven by twin triple-expansion engines of 23,000 horse power, which are calculated to give them a speed of 22 knots an hour. As the displacement is 13,680 tons, these vessels in respect of their motive power afford an interesting comparison with the British armored cruisers of the "King Alfred" class, which on a displacement of 14,100 tons are to make 23 knots an hour with 30,000 horse power. The boiler rooms of the "California" will contain 30 water-tube boilers placed in 8 water-tight compartments.

The ships will carry ammunition enough to put up a good long fight; 500 rounds being allowed the 8-inch guns, 2,800 rounds for the 6-inch guns, 4,500 rounds for the 14-pounders, 6,000 rounds for the 3-pounders, and a pretty liberal supply for the rest. Provision is to be made for closing many of the water-tight doors automatically, i. e., from a single controlling station, and every care has been taken to localize the effects of damage by shell-fire or torpedo.

In closing, we would draw attention to the protection afforded to the broadside battery, which, compared with separate casemate protection, as used on the English cruisers of the "Drake" class, is we think superior. The casemate carries 6 inches of armor on the front and 2 inches at the rear. The stretches of the ship's side between casemates are unarmored, and an enemy's shells might pass between casemates, and, bursting on the 2-inch armor of the opposite casemates, wreck them. No such damage could be suffered by the off-side battery of the "Pennsylvania," as all 5-inch and most 6-inch shells would be burst on the unbroken front wall of 5-inch armor.



Displacement, 13,680 tons. **Speed,** 22 knots. **Bunker Capacity,** 2,000 tons. **Armor:** Belt, 6 inches to 3½ inches; turrets, 6½ inches to 6 inches; barbettes, 6 inches; deck, 1½ inch to 4 inches. **Armament:** Four 8-inch, 45-caliber B. L.; fourteen 6-inch, 50-caliber R. F.; eighteen 3-inch R. F.; twelve 3-pounders; eight 1-pounders; two 3-inch field guns; two machine guns; six automatic guns. **Torpedo Tubes,** 2. **Complement,** 822.

ARMORED CRUISER "CALIFORNIA."

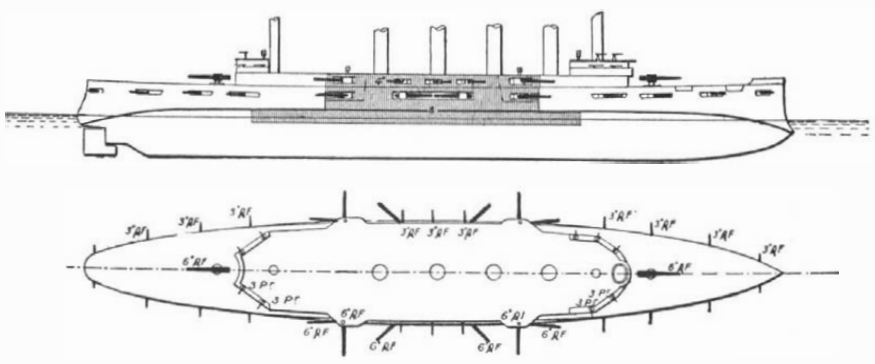
THE SEMI-ARMORED CRUISERS OF THE "ST. LOUIS" CLASS.

The three vessels of the "St. Louis" class, although they carry side armor, are down on the naval lists as protected cruisers. This is due, doubtless, to the fact that the authorization by Congress, March 2, 1901, calls for protected cruisers. As a matter of fact, the Bureau of Construction, while keeping within the limits of displacement and cost imposed by the act, has been able to add to the protective deck, which marks them as protected cruisers, a partial waterline belt and a broad belt of armor amidships reaching to the main deck. The armored cruiser carries a complete waterline belt, reaching from stem to stern. Hence the "St. Louis" class occupy a position midway between the armored and protected class, and they may be distinguished, very conveniently, as semi-armored vessels.

They compare, in size and efficiency, with the "Monmouth" class of the British navy, in which the belt is carried up to the bow, but terminates at the after casemates, the complete wall of 4-inch armor amidships in the "St. Louis" compensating for the unprotected waterline at the bow.

The main deck of the "St. Louis" is supplemented amidships with a covered superstructure, within which are located four 6-inch rapid-fire guns and six 14-pounder rapid-fire guns; outside the superstructure are two more 6-inch rapid-fire guns, located on the center line, one forward and the other aft. Located on the gun deck is the greater portion of the battery, consisting of eight 6-inch rapid-fire guns, twelve 14-pounder rapid-fire guns, and four 1-pounder rapid-fire guns. Sixteen rapid-fire guns are stationed on the superstructure deck and bridges and the remainder of the battery is located in the fighting tops of the two military masts. Additional platforms are built upon the masts to accommodate the two searchlights. Electric ammunition hoists are designed to supply the guns with the greatest rapidity, making it possible to hurl against an enemy a broadside of about twelve tons of metal per minute. The four lofty smokestacks, extending to a height of 76 feet 6 inches above the normal load waterline, provide draft for sixteen straight water-tube boilers located in four watertight compartments, which, together with the engines, are protected by the side armor, sloping deck armor, and a twelve-foot coal bunker. The inner bottom of these vessels extends to the under side of the protective deck; above the protective deck a cellulose cofferdam, 30 inches wide and 41 inches above the normal load waterline, extends throughout the length of the vessel. In the construction and equipment of the "St. Louis" class, as small a quantity as possible of wood is to be used, and wherever it is used it will be electric fire-proofed. Each vessel of this class is fitted to accommodate a flag officer and staff in conjunction with the regular complement. In commission the number of officers will be 39 and the crew will number 525 men. The waterline belt, 4 inches in thickness, extends in the wake of the engines and boilers and magazines for over one-third of the vessel's length, and reaches from several feet below to about 3 feet above the normal waterline. Side armor of the same thickness is carried up amidships to the main deck and extends between and includes the forward and after 6-inch guns on the gun-deck. The 6-inch guns at the four corners of the superstructure are also protected by 4-inch armor.

While we greatly admire these vessels, we must express a regret that the waterline armor was not carried up to the bow, even if some compromise had been necessary in the matter of speed or armament. This is an age of armored cruisers, and it is regrettable that these vessels should fall short of the requirements for want of the 120 feet of 2 to 3-inch armor necessary to complete the belt to the stem. It must be admitted that the new ships, although they are not quite in the class of the armored cruisers, are nevertheless more than a match in defensive qualities, at least, for any protected cruiser afloat.



Gun and Armor Plan; "St. Louis" Semi-Armored Cruiser Class. "St. Louis," "Charleston" and "Milwaukie."

	United States. "St. Louis."	Great Britain. "Monmouth."
Length on load waterline	424 feet.	440 feet.
Breadth, extreme	66 feet.	66 feet.
Trial displacement	9,700 tons.	9,800 tons.
Mean draught at normal displacement	23 feet 6 inches.	24 feet 6 inches.
Engines, twin-screw, I. H. P.	21,0 0	22,000
Speed	22 knots.	23 knots.
Normal coal supply	650 tons.	800 tons.
Coal bunker capacity	1,500 tons.	1,600 tons.

ARMAMENT.

Fourteen 6-inch R. F. guns.	Four 6-inch R. F. guns, in turrets.
Eighteen 14-pdr. R. F. guns.	Ten 6-inch R. F. guns in casemates.
Twelve 3-pdr. R. F. guns.	Ten 12-pdr. R. F. guns.
Four 1-pdr. automatic.	Three 3-pdr. R. F. guns.
Eight 1-pdr. R. F. guns.	Eight machine guns.
Two 3-inch R. F. field guns.	
Two machine guns, 0.30 caliber.	
Eight automatic guns, 0.30 caliber.	

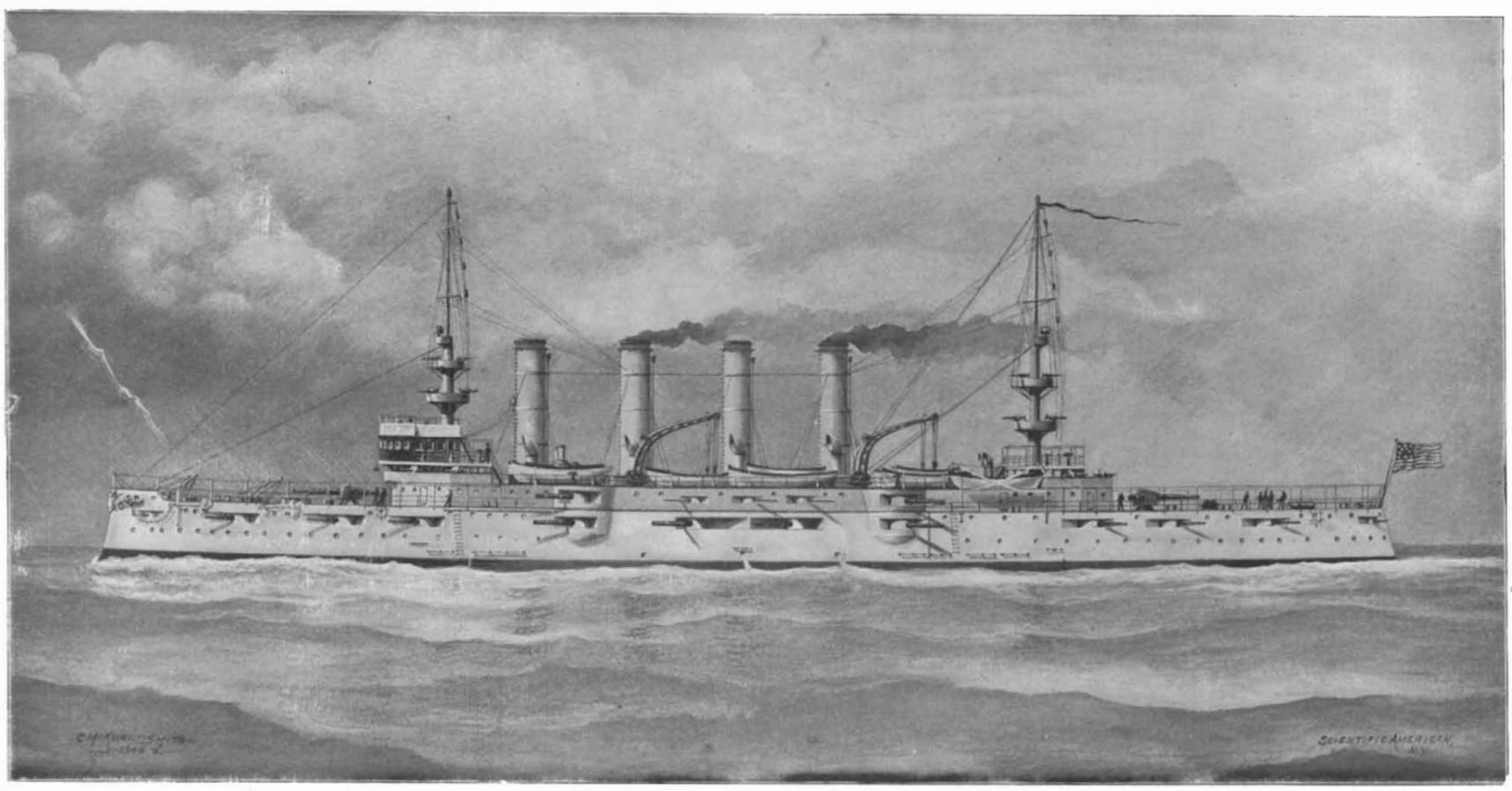
PROTECTION.

Main side armor	4 inches.	4 inches, tapering to 2 inches at bow.
Lower casemate armor	4 "	
Upper " "	4 "	
6-inch gun protection	4 "	4 inches.
Conning tower and shield	5 "	
Signal tower	4 "	
Splinter bulkheads	2 "	
Protective deck	2½ "	Two decks, 1¼ inches and ¾ inch.

Protected Cruisers.

THE SHEATHED SEMI-PROTECTED CRUISERS OF THE "DENVER" CLASS.

An Act of Congress, approved March 3, 1899, had among its provisions one for six protected cruisers "to have the highest speed compatible with good cruising qualities and great radius of action, to carry the most powerful armament suited to vessels of their class." These vessels are now being constructed according to modified designs, which include the following general dimensions and particulars: length, 292 feet; breadth, 44 feet; displacement of 3,200 tons on a mean draft of 15 feet 9 inches. The ships' bottoms will be sheathed with wood and coppered, to suit them for service in the tropics. With 4,700 indicated horse power, they are to have a speed of 16½ knots. On their mean draft, as just stated, they are to carry 467 tons of coal, the maximum bunker capacity being 700 tons. They will be armed with a main battery of ten 50-caliber, 5-inch, rapid-fire guns; eight 6-pounders; two 1-pounders, four Colt automatics, and one 3-inch wheel gun. The protective deck, if such it can be called, is only ½ inch thick, increasing to 1 inch on the slopes toward the ends and 2 inches on the slopes abreast of the machinery spaces. It is probable that no vessels in our navy have provoked more adverse comment than these, chiefly on the ground that in an age when naval construction is running to armored cruisers, these vessels have been produced with a protection which is even less than that of the average protected cruiser. The speed of 16½ knots also is far too low for an age when armored cruisers are being built by the dozen which have speeds of from 21 to 23 knots an hour; and this journal did not hesitate to pronounce the design unsatisfactory at the time they were made public. The late Chief Constructor of the Navy subsequently explained, in an article before the Society of Naval Architects, that in designing these ships the Bureau had been influenced by the comparative failure of the hgh-powered "Raleigh" and "Cincinnati" to secure the speed of 19 knots for which they were designed, and that in these ships the coal supply is limited and the coal consumption so great as to make it a serious question in making passages between distant ports. He stated that in the new designs a liberal allowance had been made for all the principal weights; that careful consideration had been given to the strength of the vessels, the scantlings having been made heavier; that the engine-room weights per indicated horse power had been made 10 per cent heavier than in the case of the "Raleigh;" that the large coal supply of 700 tons had been provided, giving them at a speed of 10 knots an hour a cruising radius of 7,000 knots without recoaling, which would cover a continuous trip from San Francisco to Manila. It was also pointed out by the Chief Constructor that as these vessels were intended

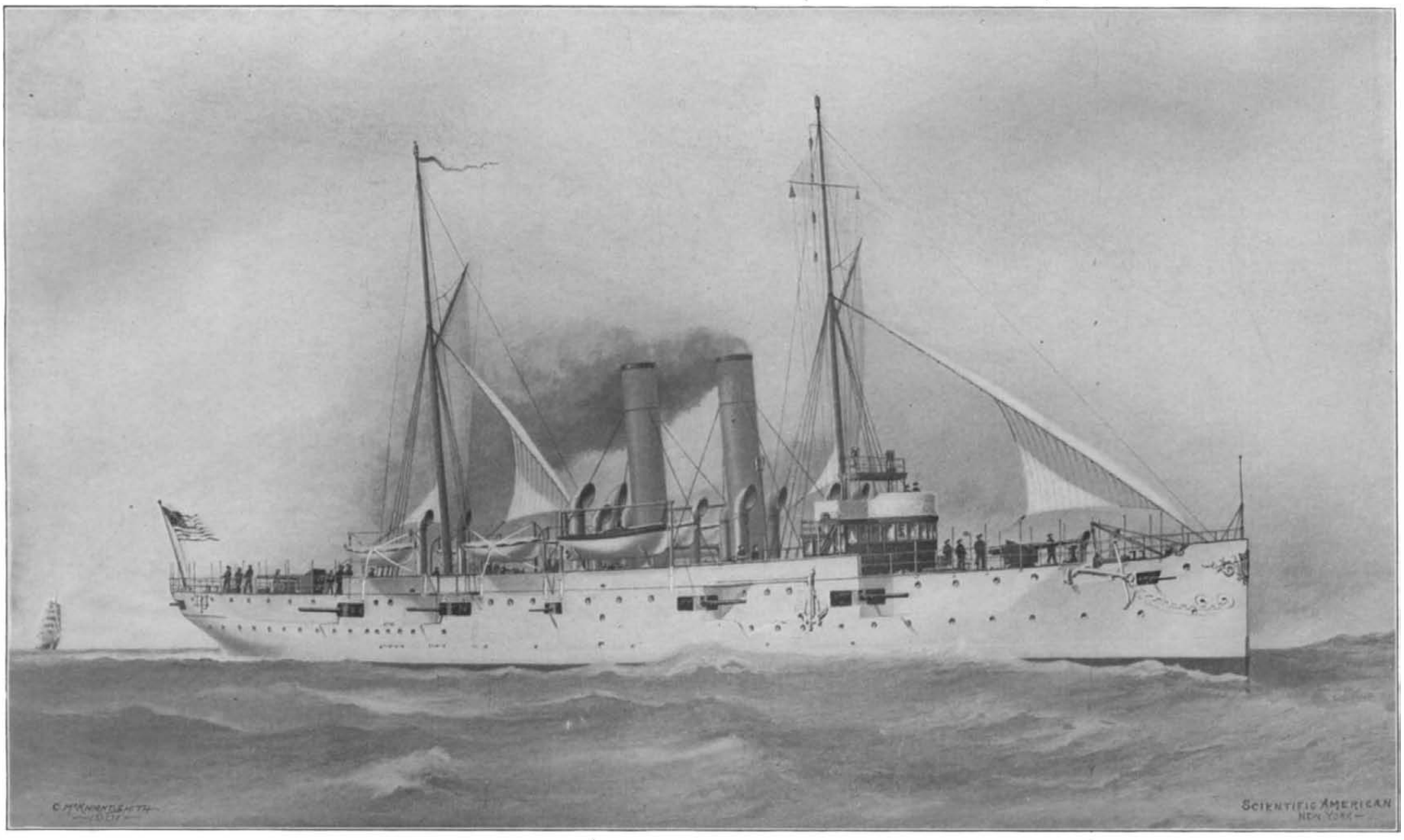


Displacement, 9,500 tons. **Speed,** 23 knots. **Bunker Capacity,** 1,500 tons. **Armor:** Belt, 4 inches; topsides, 4 inches; deck, flat, 2 inches; slopes, 3 inches. **Armament:** Fourteen 6-inch R. F.; eighteen 3-inch R. F.; twelve 3-pounder semi-automatic four 1-pounder automatic; two 3-inch field guns; two .30-caliber machine guns; eight .30-caliber automatics. **Complement,** 564.

SEMI-ARMORED CRUISER "ST. LOUIS."

for long voyages and foreign service, liberal berthing accommodation had been made for the crew and more spacious staterooms for the officers. It was further shown that there was no open waist amidships, as in the "Raleigh," the upper deck being carried flush throughout the vessel, and thus giving more deck room and a higher freeboard; and, lastly, that, though the waterline protection is exceedingly light, consisting merely of an inner sloping deck 1 and 2 inches in thickness, considerable protection is afforded by a cofferdam 27 inches in width by 4 feet in depth, filled with waterproof corn-pith cellulose; while back of the cofferdam, in the wake of the engines and boilers, will be coal bunkers presenting a horizontal protection of from 8 to 10 feet of coal when the bunkers are full.

We have no doubt whatever that the prediction of the late Chief Constructor that the vessels will be exceedingly comfortable and will become, on that account, popular with officers and crew, will be fulfilled, at least in peace times; and no doubt the vessels will find a useful sphere of work in representing this government at foreign stations. We cannot help asking the question, however, as to what would be the fate of one of these slow, poorly-protected vessels should she fall in with an armored, or even a protected, cruiser of 20 knots speed or over, that was capable of overhauling her and overmatching her with the power of her armament. The type is one that is too slow to run away and too poorly protected to stand up and fight a modern cruiser with any great likelihood of success. What, for instance, would happen to the ½-inch protective (*sic*) deck if high-explosive shells, even of small caliber, were bursting above it?



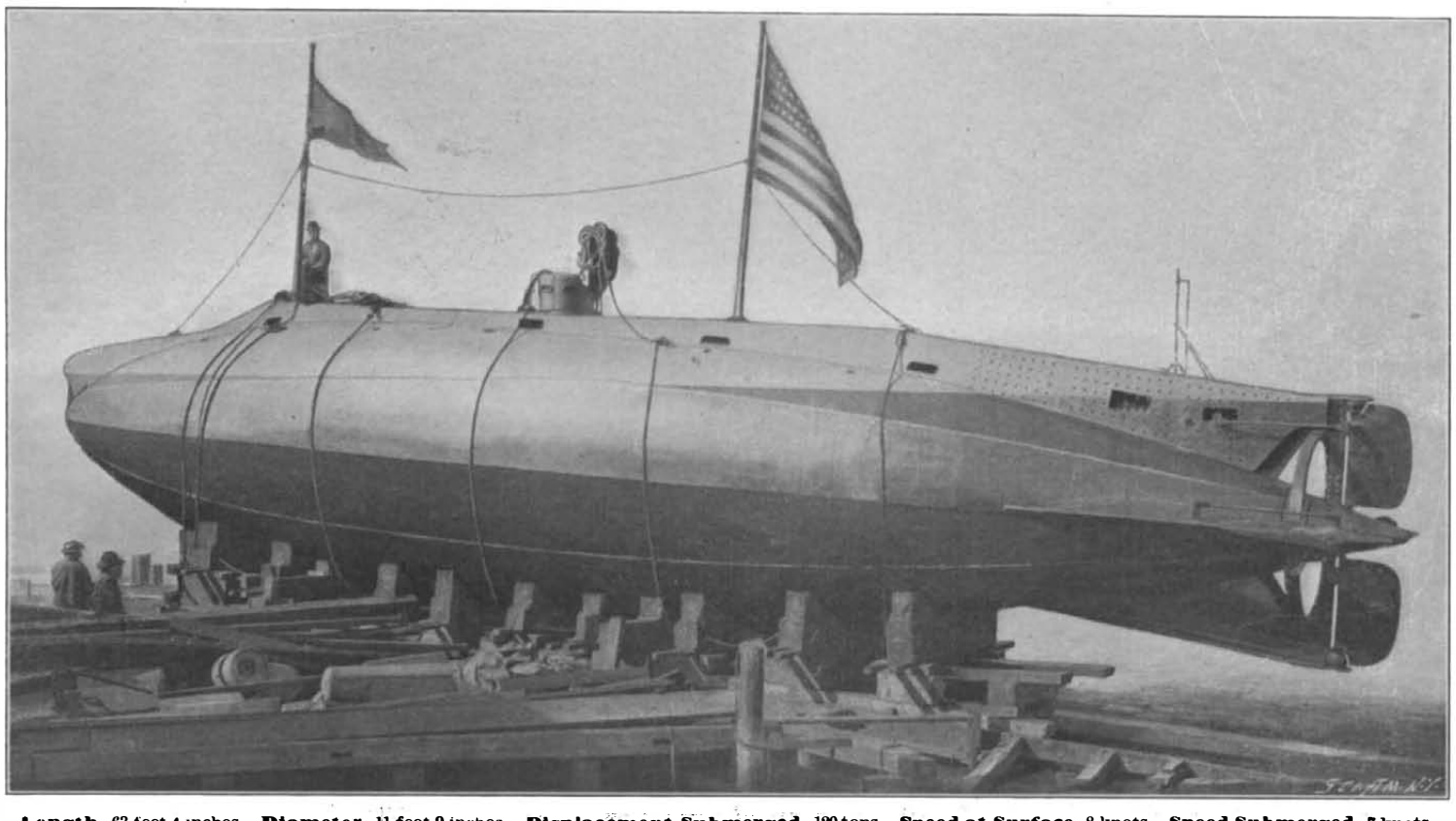
Displacement, 8,200 tons. **Speed,** 16½ knots. **Bunker Capacity,** 700 tons. **Armor:** Deck, ½ inch on flat, 1 inch to 2 inches on slopes. **Armament:** Ten 5-inch R. F.; eight 6-pounders; two 1-pounders four Colts; one 3-inch field gun. **Complement,** 293.

SEMI-PROTECTED CRUISER "DENVER." ALSO "CLEVELAND," "CHATTANOOGA," "DES MOINES," "GALVESTON," AND "TACOMA."

Submarine Torpedo Boats.

THE HOLLAND SUBMARINE TORPEDO BOAT CLASS.

The United States government has now no less than eight submarine boats constructed or under construction. These are of the Holland type, which has been adopted by our own and by the British navy. In the absence of any experience with the submarine under the hard conditions of actual warfare, it is difficult to assign to this novel craft its proper value as a fighting unit of the navy. Just now, its value varies from nothing to everything, according to the conservative judgment or over-sanguine temperament of the critic. The friends and promoters of the submarine have undoubtedly committed the old fault of claiming too much, and there will come, if there has not already begun, a protest on the part of practical naval men against the impossible qualities which have been ascribed to what is, at best, an untried device. The method of attack of the submarine is outlined somewhat as follows: The little craft will steam to within striking distance of a battleship, and before her conning tower can be detected, will sink beneath the surface, approaching, still unsuspected, until within view of the vessel's unprotected hull. She will then discharge her torpedo and stealing away under water, will come to the surface beyond range of the enemy's guns. All this is picturesque and, if practicable, would certainly be awe-inspiring. There is one difficulty, however, which would render an exploit of this kind exceedingly hazardous, and that is the impossibility of seeing under water with sufficient clearness for maneuvering. When the boat is submerged the navigator can see but dimly, if at all, and his course, as laid, is subject to errors in both a vertical and a horizontal plane. The chief value of the submarine will lie in its moral effect in keeping the enemy continuously on the move, particularly should he be engaged in blockading a harbor in which a few submarines were known to exist.



Length, 63 feet 4 inches. **Diameter,** 11 feet 9 inches. **Displacement Submerged,** 120 tons. **Speed at Surface,** 8 knots. **Speed Submerged,** 7 knots. **Gasoline Tank Capacity,** 850 gallons. **Armament:** One torpedo-expulsion tube; five 45 cm. by 11 feet 8 inches Whitehead torpedoes.

THE HOLLAND SUBMARINE TORPEDO-BOAT CLASS—"HOLLAND," "ADDER," "GRAMPUS," "MOCCASIN," "PIKE," "PORPOISE," AND "SHARK."

The first of our torpedo boats, the "Holland," is 53 feet 11 inches long, 10 feet 3 inches diameter and 74 tons displacement, and is driven by a 50-horse power engine. She carries one torpedo tube and one dynamite gun as her armament. The six vessels author-

ized June 7, 1900, are 63 feet 4 inches in length, 11 feet 9 inches in diameter and have a displacement, submerged, of 120 tons. When on the surface, they are driven by a single-screw, four-cylinder, Otto gasoline engine of 160 horse power. They are provided with a generator of 70 horse power, which may be either driven by the gasoline engine for charging the batteries, or, when the boat is submerged, the generator can be thrown onto the batteries and used as a motor for driving the propeller.

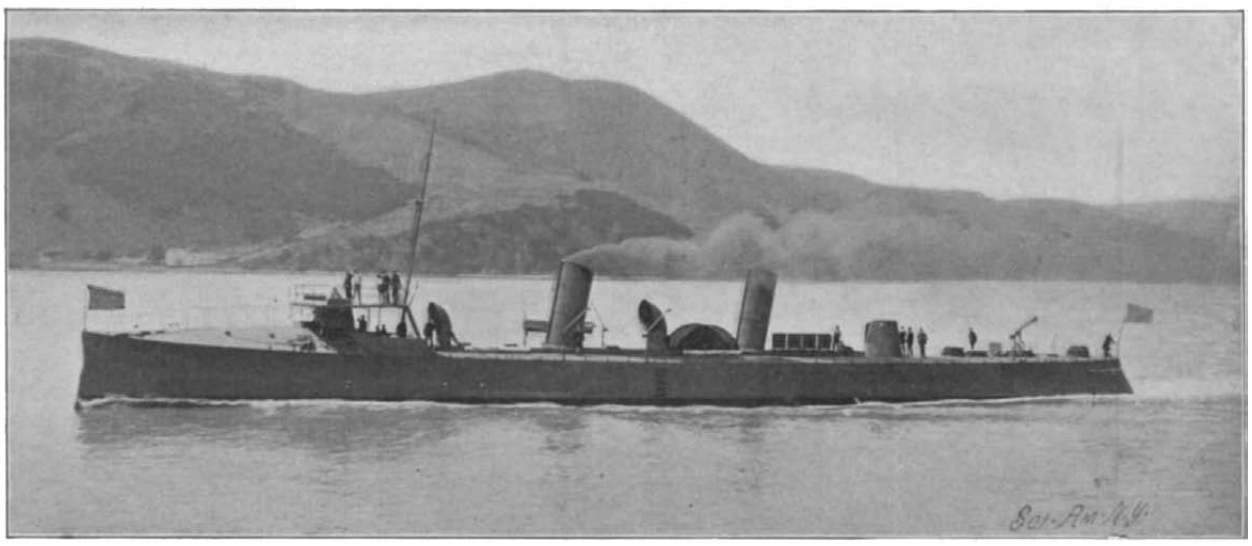
These six submarines are built with a double bottom and with three watertight compartments. In the forward compartment are the gasoline tank, the expulsion tube, and the air flasks for the discharge of the torpedoes. The amidship compartment contains the main ballast tanks, which are located in the double bottom, and above them are the storage batteries, the torpedoes, and the air flasks in which fresh air for the crew is stored at 2,000 pounds pressure. In the third compartment at the stern are the gasoline engine, the motor, the clutches and the steering gear. Submersion is achieved by trimming tanks assisted by a pair of horizontal diving rudders at the stern. The vessel is controlled from a conning tower protected with four inches of armor. Considerable experience has been gained with the "Holland," which has served as a school of instruction in which crews and officers are enabled to familiarize themselves with this type of craft. The most interesting experiment thus far was the recent sinking of one of the "Hollands" to the bottom of Peconic Bay, where she remained for fifteen hours without coming to the surface. The officers and crew experienced no inconvenience whatever from vitiated atmosphere. Whether the same immunity would be realized were the batteries and motor power in operation is, of course, an open question which could only be solved by an actual trial.

Torpedo-Boats and Destroyers.

TORPEDO-BOAT "FARRAGUT."

In the matter of torpedo-boats and torpedo-boat destroyers the United States navy has been content to pursue a conservative course, rather than rush into the wholesale construction of these craft with that precipitancy which has characterized some European navies. Up to the year 1890 we did not have a single torpedo-boat in commission, and at the present time we have but thirty-five of these little vessels, all told, on our naval list; whereas there are some navies which number them by the hundred. The value of the torpedo-boat is even to-day an unsettled question, and the complete loss of the destroyers "Cobra" and "Viper" during the past few months, together with the severe straining which has taken place in heavy weather of other craft of the torpedo-boat destroyer type, has reopened the question of the proper design, size and strength of torpedo craft to render them serviceable and safe upon the high seas. Hence, it is a matter of congratulation that, if we decide to increase our torpedo fleet, we have the advantage of experience gained in the maneuvers of foreign fleets; while, on the other hand, should the torpedo-boat pass out of fashion, we shall not have a large tonnage of worthless material on our hands. Our thirty-five torpedo-boats vary in size and speed from the "Gwin," of 46 tons and 21 knots speed, to the "Stringham," of 340 tons and 30 knots speed, and the "Bailey," "Goldsborough" and "Farragut," of 247 to 280 tons displacement and 30 knots speed. The last three craft were originally designed as torpedo-boat destroyers; but our Naval Constructors reached the conclusion that the destroyer, to be fully equal to its work, should be a larger and more powerful vessel, and consequently when the sixteen torpedo-boat destroyers of the "Bainbridge" type were designed the four vessels named above were relegated to the torpedo-boat class. As torpedo-boats they will be the largest in the world; indeed, they will exceed in size many of the destroyers in other navies. The "Farragut," which is herewith shown after her launch from the Union Iron Works, San Francisco, is typical of the larger torpedo-boats. She is 213 feet in length, 20 feet 7¾ inches in beam, and has a mean draft of 6 feet, at which draft she displaces 279 tons. She is driven by twin-screw, vertical, triple-expansion engines of 5,600 horse power, and she has made on trial a speed of 30.13 knots per hour. The bunkers have a capacity of 95 tons. The armament consists of two long 18-inch Whitehead torpedo tubes and four 6-pounder rapid-fire guns. She has a complement of 66 officers and men.

Of the total thirty-five torpedo-boats in our navy twenty-three have been commissioned or completed since the close of the Spanish war.



Copyright 1900. E. Muller.

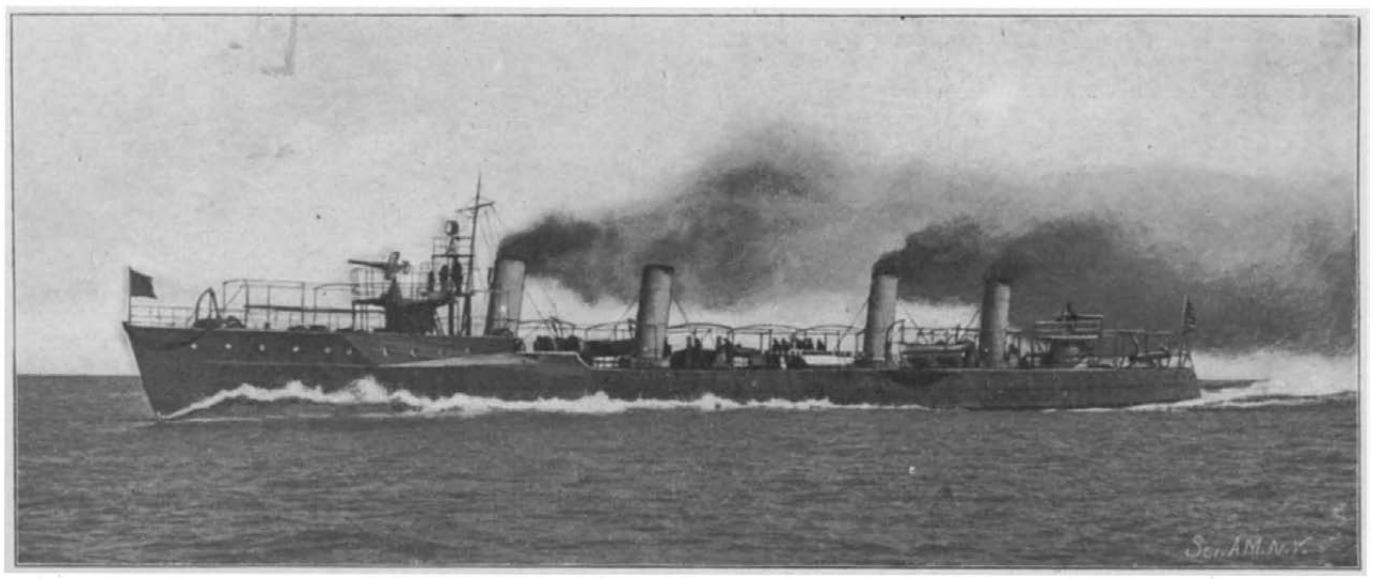
Length, 213 feet. **Beam,** 20 feet 7¾ inches. **Mean Draft,** 6 feet. **Displacement,** 279 tons. **Speed,** 30.1 knots. **Bunker Capacity,** 95 tons. **Armament:** Two 18-inch Whitehead torpedoes; four 6-pounder R. F. guns. **Complement,** 66.

TORPEDO-BOAT "FARRAGUT."

TORPEDO-BOAT DESTROYER "PERRY."

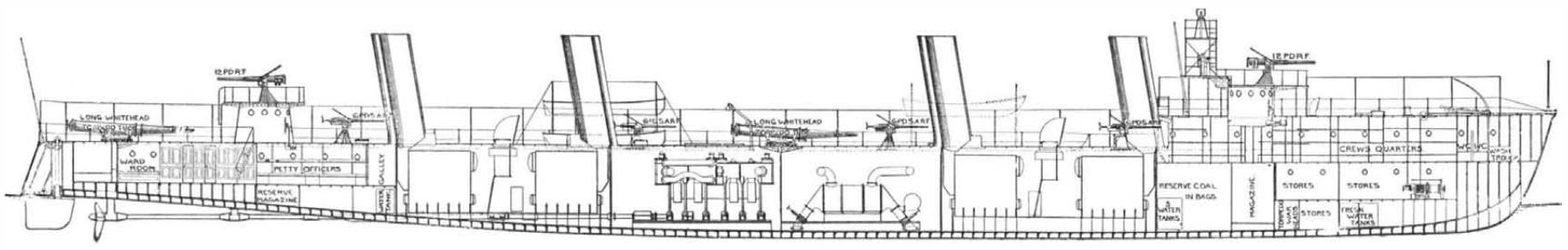
The torpedo-boat destroyer owes its existence to the theoretical prowess of the torpedo-boat. The torpedo-boat was one of those devices which periodically figure in the scare-head lines of the daily press as "annihilators," and the torpedo-boat destroyer is the annihilator of the annihilator. As soon as a few of the early torpedo-boats were built and began to maneuver with the fleets, it was found that they were altogether unseaworthy, at least so far as maintaining their speed in a jump of a sea was concerned. Hence, the idea of the torpedo-boat destroyer—a larger edition of the torpedo-boat, armed with heavier guns, and, by virtue of her greater speed and weight, able to run down the torpedo-boat and sink her. As the tendency in the construction of torpedo craft, whether of the torpedo-boat or destroyer type, has always been toward increase in size, our Naval Constructors when designing the sixteen torpedo destroyers, authorized May 4, 1898, very wisely made them considerably larger than the destroyers which were being built for foreign navies. We present an illustration of the "Perry," built by the Union Iron Works, at San Francisco, which was taken when she was making one of her trial runs at full speed. The cylinders of the "Perry" are 20½, 32, 38, and 38-inch diameter by 22-inch stroke. At 327 revolutions the horse power is about 8,000. The steam at the boilers is at 300 and at the engines 250 pounds pressure. There are four Thornycroft water-tube boilers, two forward of the engines and two aft.

Nine of the destroyers are of 420 tons displacement and are designed for speeds of 28 and 29 knots with 8,000 indicated horse power. They are known as the "Bainbridge," "Barry," "Chauncey," "Dale," "Decatur," "Paul Jones," "Perry," "Preble," and "Stewart," being named after heroes whose names are associated with the most brilliant episodes of our naval history. Each destroyer carries on the main deck two torpedo tubes for the discharge of the 18-inch Whitehead torpedo. The armament consists of two 12-pounder rapid-fire guns carried, one forward and one aft, above the conning towers and protected by shields. There are also five 6-pounders carried in broadside on the main deck. These vessels have a length of 245 feet, a beam of 23 feet 7¼ inches, and a draught of 6 feet



Length, 245 feet. **Breadth,** 23 feet 7¼ inches. **Draft,** 6 feet 6 inches. **Displacement,** 420 tons. **Contract Speed,** 29 knots. **Bunker Capacity,** 139 tons. **Armament:** Two long 18-inch Whitehead torpedo tubes; two 3-inch R. F. guns; five 6-pounders. **Complement,** 73.

TORPEDO-BOAT DESTROYER "PERRY"—"BAINBRIDGE" CLASS OF SIXTEEN VESSELS.



LONGITUDINAL SECTION, SHOWING INTERNAL ARRANGEMENTS OF TORPEDO-BOAT DESTROYERS.

Remington Typewriters

ARE IN GREATER DEMAND THAN EVER BEFORE.

In **1898,** The sale of the REMINGTON was 25 per cent. greater than in any previous year of its history.

In **1899,** REMINGTON sales exceeded those of the previous year by an even greater percentage.

In **1900,** More REMINGTONS were again sold than ever before in any year of its history.

In **1901,** More REMINGTONS have been sold in *eleven months* than in any entire year of its former history.

The annual sale of the REMINGTON has always been greater than that of any other typewriter—of many others combined. It is known the world over as **the most durable and reliable writing machine.**

WYCKOFF, SEAMANS & BENEDICT,

327 BROADWAY, NEW YORK.

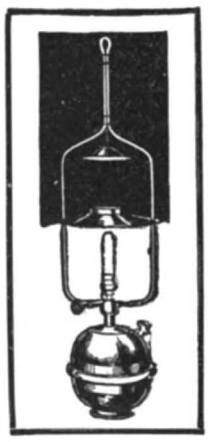
$80 in 6 days

is what O. W. Clement, of Colon, Mich., recently received

SELLING THE Turner "Little Wonder" Lamp

This is not an extraordinary experience at all to anyone acquainted with the remarkable merits and easily demonstratable selling qualities of this Lamp. It is what many of our other agents are doing, and some, more than that. After careful investigation it is estimated that over

500,000 GASOLINE LAMPS



were sold last season, Many more will be sold this season. Are you not ready to pocket some of the profits? Big profits.

The **"LITTLE WONDER" LAMP** is the latest invention of the greatest inventor of gasoline lamps. Generates hydro-carbon gas from gasoline (wholly different from gasoline lamps). Possesses under generator pressure overcoming the hitherto impossible obstacle of combining volume of light with non-clogging feature. Used with or without glass. 500 candle power arc light costs ⅓ cent per hour. This Lamp can be adapted to all interior lighting purposes. **ABSOLUTELY UNAPPROACHABLE.** Producing the **BRIGHTEST KNOWN LIGHT,** even more brilliant than electricity. There is no other lamp or light comparable with it, both in intrinsic value and selling qualities.

OUR GUARANTEE We have been in business in Chicago 30 years. We are the largest manufacturers in our line in the world. We back this lamp by our reputation. We agree to make good by repair or replacement at our factory within one year any part of this lamp which is proven defective in material or workmanship. The **"Little Wonder"** lamp was invented after many years of experience in the manufacture of lamps and after our experts had tested nearly every lamp now in the market. It is pronounced a marvel by health and insurance authorities. We unhesitatingly affirm that the **"Little Wonder"** is the superior of any other lamp made.

IT SELLS ITSELF. Put the **Turner "Little Wonder" Light** on exhibition, preferably after dark, and it positively sells itself. Everyone that looks at it is surprised at the steady, brilliant illumination which this light will give. It can be seen to be smokeless and odorless, and very handy; and when the people are told what it costs to operate it and learn of our absolute guarantee, together with its absolute safety, **sales can be made at once on the spot.**

WE WANT RESPONSIBLE AGENTS to whom we have a proposition to make that will afford them more money than they can possibly earn in any other manner. **We want live men and are willing to pay well for them.** We know that we have a wonderful invention and are willing to back it with our guarantee and the reputation of our house If you are an enterprising man, why be content in your present position when the opportunity is yours to **double your present income** with the largest concern in our line in the world?

REMEMBER we appoint but one agent in a place. Others are making hundreds of dollars a month. You can, too. We are responsible and we guarantee this lamp to be all we represent it. Don't miss this opportunity. Write to-day. Address

THE TURNER BRASS WORKS

82 E. KINZIE STREET CHICAGO, ILL.

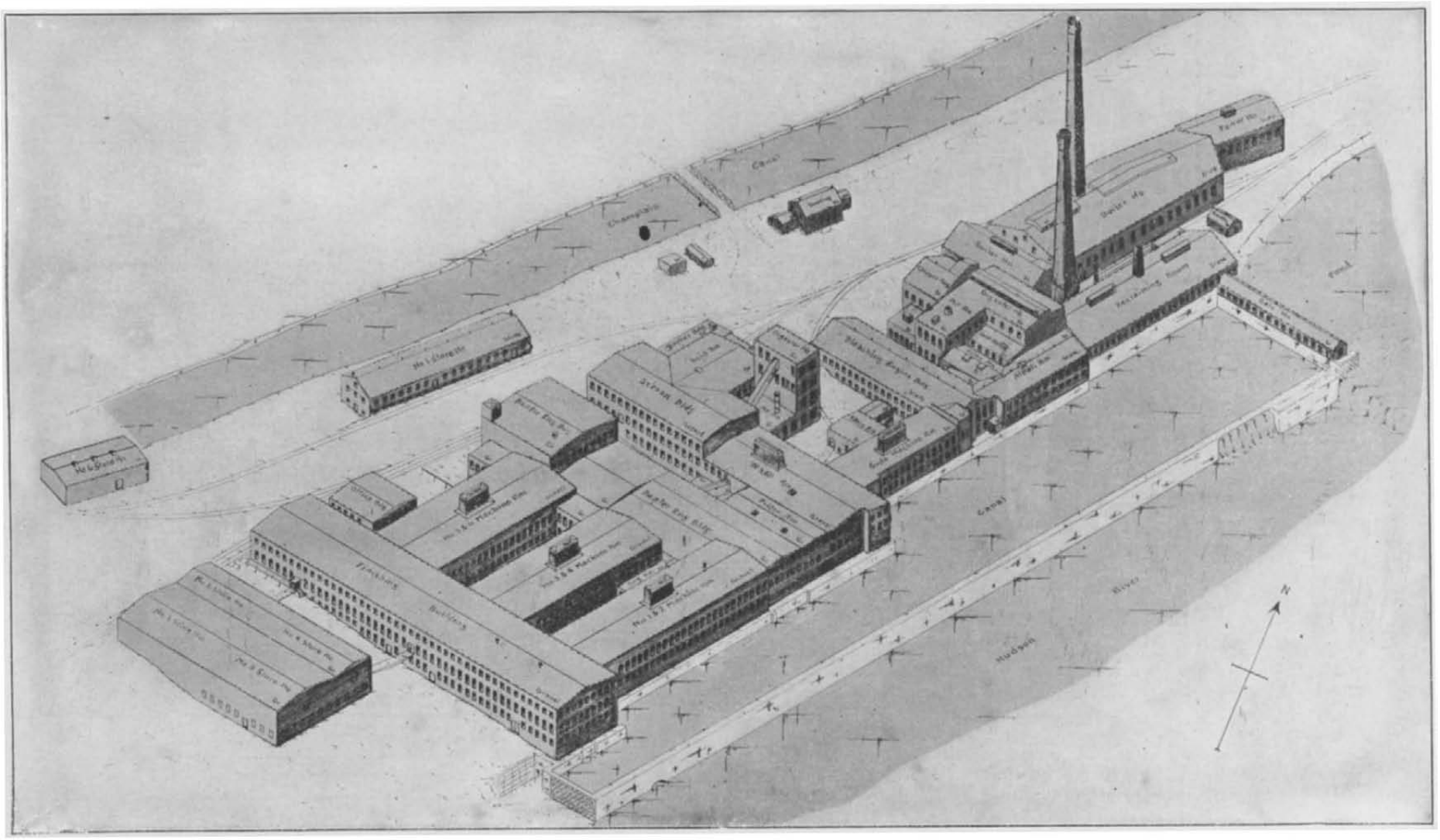
THE DUNCAN COMPANY,

Times Building, New York Ctiy.

MANUFACTURERS OF

MACHINE FINISHED AND SUPER-CALENDERED PAPERS.

SULPHITE AND SODA FIBRES.



GENERAL VIEW OF THE DUNCAN COMPANY'S PLANT ON THE HUDSON RIVER AT MECHANICSVILLE, N. Y.

TABLE OF VESSELS COMMISSIONED, COMPLETED, BUILDING, OR AUTHORIZED SINCE THE SPANISH WAR.

BATTLESHIPS AND ARMORED CRUISERS.

Name.	Type.	Displacement in Tons.	Speed in Knots.	Armor. Belt.	Armor. Gun Positions.	Armament. Main.	Armament. Secondary.
Kearsarge	Battleship.	11,540	16.8	16½ in.	17 in.—15 in.	4 13-in. B. L. R. 4 8-in. B. L. R. 14 5-in. R. F. G.	20 6-pounders. 8 1 " 6 small guns.
Kentucky	"	"	16.9	"	"	"	"
Alabama	"	11,565	17.1	16½ in.	15 in.—14 in.	4 13-in. B. L. R. 14 6-in. R. F. G.	16 6-pounders. 6 1 " 6 small guns.
Illinois	"	"	17.4	"	"	"	"
Wisconsin	"	"	17.2	"	"	"	"
Maine	"	12,300	18.0	11 in.	12 in.—12 in.	4 12-in. B. L. R. 16 6-in. R. F. G. 6 3-in. R. F. G.	8 6-pounders. 6 1 " 4 small guns.
Missouri	"	"	"	"	"	"	"
Ohio	"	"	"	"	"	"	"
Georgia	"	14,948	19.0	11 in.	11 in.—10 in.	4 12-in. B. L. R. 8 8-in. B. L. R. 12 6-in. R. F. G. 12 3-in. R. F. G.	12 3-pounders. 8 1 " 10 small guns.
Nebraska	"	"	"	"	"	"	"
New Jersey	"	"	"	"	"	"	"
Rhode Island	"	"	"	"	"	"	"
Virginia	"	"	"	"	"	"	"
Arkansas	Monitor.	3,235	11.5	11 in.	11 in.—10 in.	2 12-in. B. L. R. 4 4-in. R. F. G.	3 6-pounders. 6 1 " 2 Colts.
Florida	"	"	"	"	"	"	"
Nevada	"	"	"	"	"	"	"
Wyoming	"	"	"	"	"	"	"
California	Armored Cruiser.	13,680	22.0	6 in.—5 in.	6½ in.—6 in.	4 8-in. B. L. R. 14 6-in. R. F. G. 18 3-in. R. F. G.	12 3-pounders. 8 1 " 10 small guns.
Colorado	" "	"	"	"	"	"	"
Maryland	" "	"	"	"	"	"	"
Pennsylvania	" "	"	"	"	"	"	"
South Dakota	" "	"	"	"	"	"	"
West Virginia	" "	"	"	"	"	"	"
Charleston	Semi-armored Cruiser.	9,700	22.0	4 in.	Deck 3 in.—2 in.	14 6-in. R. F. G. 18 3-in. R. F. G.	12 3-pounders. 24 small guns.
Milwaukie	" "	"	"	"	"	"	"
St. Louis	" "	"	"	"	"	"	"

UNARMORED CRUISERS AND GUNBOATS.

Name.	Type.	Displacement in Tons.	Speed in Knots.	Protective Deck. Slopes.	Protective Deck. Flat.	Armament. Main.	Armament. Secondary.
Chattanooga	Semi-protected Cruiser.	3,200	16.5	2 in.—1 in.	½ inch.	10 5-in. R. F. G.	8 6-pounders. 6 small guns.
Cleveland	" "	"	"	"	"	"	"
Denver	" "	"	"	"	"	"	"
Des Moines	" "	"	"	"	"	"	"
Galveston	" "	"	"	"	"	"	"
Tacoma	" "	"	"	"	"	"	"
Reina Mercedes	Unprotected Cruiser.	3,090	17.0	....	.....	.....	.....
Don Juan de Austria	Gunboat.	1,130	14.0	.....	.....	4 5-in. R. F. G.	4 6-pounders. 4 Colts.
General Alava	"	1,390	10.5	.....	.....	.....	6 Nordenfelts.
Isla de Cuba	" Formerly Spanish.	1,125	14.0	2½ in.	1½ inches.	4 4-in. R. F. G.	4 6-pounders. 4 Colts.
Isla de Luzon	" "	"	"	"	"	"	4 6-pounders. 4 Colts.
*Alvarado	" "	106	19.0	....	.....	.....	2 3-pounders. 2 Colts.
†Gunboat No. 16	"	.....	.....	.....	.....	.....	.....

* Twenty-one of this type of Gunboat captured or purchased from Spain, varying from 42 to 560 tons displacement and from 8 to 19 knots speed.

† Contract not awarded.

DESTROYERS AND TORPEDO BOATS.

Name.	Type.	Displacement in Tons.	Speed in Knots.	Armament. Torpedo Tubes.	Armament. Guns.
Bainbridge, Barry, Chauncey, Dale, Decatur, Paul Jones, Perry, Preble, Stewart	Torpedo-boat Destroyers.	420	29.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Lawrence, Macdonough, Truxton	Torpedo-boat Destroyers.	402	30.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Whipple, Worden	Torpedo-boat Destroyers.	433	30.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Hopkins, Hull	Torpedo-boat Destroyers.	408	29.0	2 18-inch Whitehead.	2 3-inch and 5 6-pounders R. F. G.
Bagley	Torpedo-boat.	175	29.2	3 18-inch Whitehead.	3 3-pounders R. F.
Bailey	"	280	30.2	2 " "	4 6-pounders R. F.
Barney	"	175	29.1	3 " "	3 3-pounders R. F.
Biddle	"	175	28.0	3 " "	" "
Blakely	"	200	26.0	3 " "	" "
Davis	"	154	23.4	3 " "	3 1-pounders R. F.
Dahlgren	"	146	30.5	2 " "	4 1-pounders R. F.
De Long	"	200	26.0	3 " "	3 3-pounders R. F.
Farragut	"	279	30.1	2 " "	4 6-pounders R. F.
Fox	"	154	23.1	3 " "	3 1-pounders R. F.
Goldsborough	"	247	30.0	2 " "	4 6-pounders R. F.
MacKenzie	"	65	20.1	2 " "	1 1-pounder R. F.
Nicholson	"	174	26.0	3 " "	3 3-pounders R. F.
O'Brien	"	174	26.0	3 " "	3 3-pounders R. F.
Rowan	"	182	27.0	3 " "	4 1-pounders R. F.
Shubrick	"	200	25.0	3 " "	3 3-pounders R. F.
Stockton	"	200	24.7	3 " "	3 3-pounders R. F.
Stringham	"	340	30.0	2 " "	7 6-pounders R. F.
T. A. M. Craven	"	146	30.5	2 " "	4 1-pounders R. F.
Thornton	"	200	26.0	3 " "	3 3-pounders R. F.
Tingey	"	165	26.0	3 " "	" "
Wilkes	"	165	26.5	3 " "	" "
Holland	Submarine.	74	8	1 Torpedo Tube.	1 Dynamite Gun.
Adder	"	120	8—7	" "	5 45-cm. Whiteheads.
Grampus	"	"	"	" "	" "
Moccasin	"	"	"	" "	" "
Pike	"	"	"	" "	" "
Shark	"	"	"	" "	" "
Porpoise	"	"	"	" "	" "
Plunger	"	....	....	.....	.....

6 inches. They are capable of carrying 139 tons of coal closely stowed in their bunkers, and the complement consists of four officers and sixty men. One excellent feature, which will give them considerable advantage over some of the latest boats that have been constructed for foreign navies, is that, in addition to their relatively large size, they are provided with a long forecastle deck, which gives them an extreme freeboard forward of 14 feet, the freeboard amidships being about 9 feet. This will considerably improve their speed in steaming to windward in heavy weather. Three of these vessels have been constructed by Neafie & Levy, Philadelphia; two by William R. Trigg & Company, Richmond, Va.; three, as mentioned, by the Union Iron Works, of San Francisco; and one by the Gas Engine and Power Company, Morris Heights, N. Y.

The "Hopkins" and the "Hull," which are being built by the Harlan & Hollingsworth Company, Wil-

Name.	Number of Vessels.	Length.	Beam.	Draught.	Displacement, Tons.	Horse Power.	Speed, Knots.	Bunker Capacity.	Torpedo Tubes.	Armament.
		Ft.In.	Ft.In.	Ft.In.						
Bainbridge	9	245	23 7½	6 6	420	8,000	29	139	2 18-in.	2 12-pdr., 5 6-pdr.
Hopkins	2	244	24 6	6 0	408	7,200	29	150	"	2 12-pdr., 5 6-pdr.
Lawrence	2	242 3	22 3	6 2⅛	400	8,400	30	115	"	2 12-pdr., 5 6-pdr.
Worden	3	248	23 3	6 0	433	8,300	30	232	"	2 12-pdr., 5 6-pdr.

mington, Del., are somewhat smaller vessels. They have about the same length, a foot more beam, and 6 inches less draught with a displacement of 408 tons. They were designed to achieve 29 knots with 7,200 indicated horse power, and the bunker capacity will be 150 tons, the armament and the complement of officers and crew being the same as for the "Bainbridge." The "Lawrence" and the "Macdonough," which are being built by the Fore River Engine Company, Weymouth, Mass., are the smallest vessels of the fleet. They are of 400 tons displacement, and they were designed to achieve a speed of 30 knots with 8,400 indicated horse power. The coal capacity is less, namely, 115 tons; particulars of the armament and the complement are the same as for the other vessels. The largest of the fleet are the "Truxton," "Whipple," and "Worden," building by the Maryland Steel Company, at Sparrows Point, Md. They are 248 feet in length, 23 feet 3 inches beam, and on a draught of 6 feet they have a displacement of 433 tons. They have the large bunker capacity of 232 tons—a very valuable feature—and they are to make a speed of 30 knots with a development of 8,300 horse power.

These destroyers cannot fail to produce a favorable impression. Their size, roominess, coal capacity, and powerful armament, and, above all, their good seagoing qualities and high speed, will place them in the very front rank of this type of vessel.

OUR RELATIVE STANDING AMONG THE NAVAL POWERS.

In the accompanying table it will be observed we have placed the United States navy in the fourth position in rank, with England first, France second, and Russia third. At first glance, when comparing the navies by the total number of ships they possess, it would seem as though Germany, with her total of 77, should take precedence over the United States with 62. It must be borne in mind, however, that the truest test of naval strength lies in a comparison of the total displacement and a consideration of the distribution of that displacement among the various types of warships which it represents. Judged by these two tests we hold a remarkable lead over Germany. Thus the 77 German ships represent a total displacement of 395,858 tons, whereas the 62 ships of the United States Navy total up 474,179 tons, an excess of 78,321 tons. The fighting strength of a navy lies in its line of battle; that is in the first-class battleships and armored cruisers that can match armor with armor, heavy gun with heavy gun. Here our superiority is overwhelming, for we can put in line 28 armored ships of 339,444 tons total displacement against Germany's 20 first-class armored ships of 215,254 tons total. Not only so, but ship for ship our 15,000-ton "Georgias" entirely outclass the 12,000-ton German "Wittelsbachs," and our 14,000-ton armored cruisers of the "Pennsylvania" class have an equal superiority to the 9,000-ton "Prinz Heinrich" class.

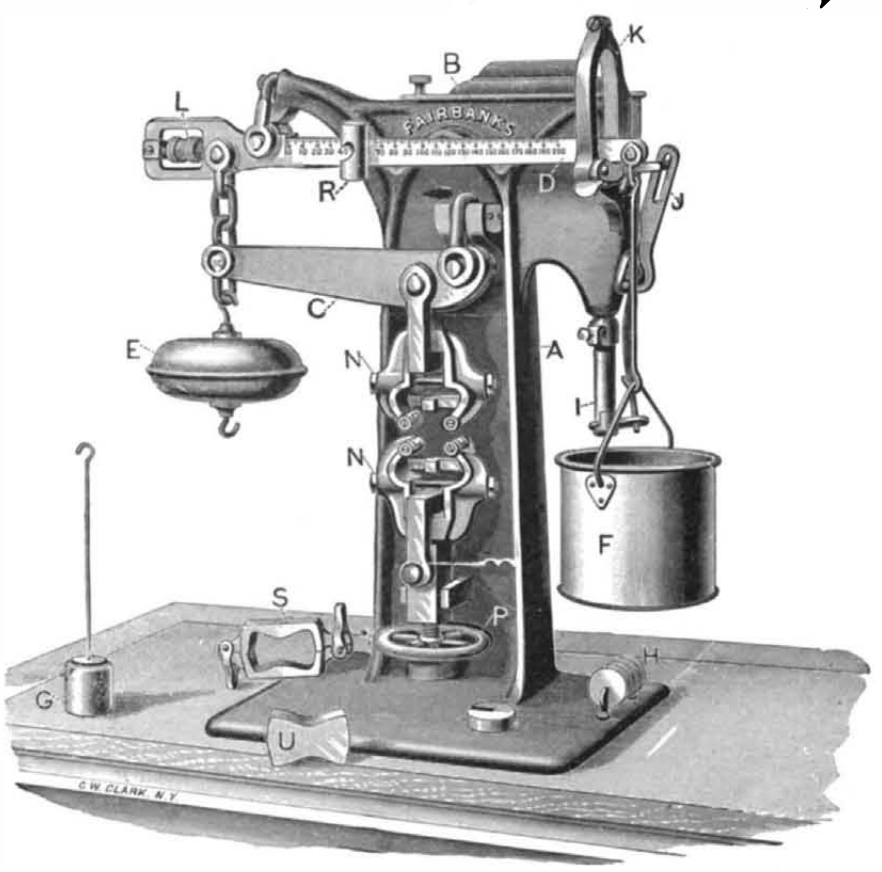
COMPARATIVE TABLE OF OUR OWN AND FOREIGN NAVIES.

Total Number of Ships Built or Building as per Brassey's Annual, 1901.

Class.	Great Britain	France	Russia	United States	Germany	Italy	Japan
Battleships.							
1st Class	38	13	14	17	16	9	6
2nd Class	11	10	10	—	—	5	—
3d Class	10	11	1	1	7	2	1
Total	59	34	25	18	23	16	7
Cruisers.							
1st Class	43	19	13	13	5	5	6
2nd Class	62	23	7	16	8	5	10
3d Class	44	13	5	5	18	11	6
Total	149	55	25	34	31	21	22
Coast Defense Vessels.	17	14	16	10	19	3	1
Torpedo Gunboats.	34	21	9	—	4	17	2
Total Number of Warships	259	124	75	62	77	57	32

FAIRBANKS'

Cement Testing Machines



and Appliances.

Pamphlet No. 327, "CEMENT TESTING," mailed upon Application.

THE FAIRBANKS COMPANY, 311 Broadway, NEW YORK.

Established 1871. **Incorporated 1888.**

H. & R. Automatic Double Action Revolver with Knife Attachment.

This arm with knife attachment was especially designed for export trade. The knife is made of fine steel, well tempered, and forms practically a double weapon.

H. & R. Hammerless Revolver.

An absolutely safe arm. Impossible to discharge accidentally. 32 and 38 Calibers. Has independent cylinder stop.

H. & R. Automatic Double Action Revolver.

The most popular medium priced revolver on the market. Barrel, cylinder and all working parts of the quality of steel best adapted to their particular uses. 32 and 38 Calibers.

Makers of H. & R. Single Guns.

HARRINGTON & RICHARDSON ARMS CO.,

Dept. "S," Worcester, Mass., U. S. A.

CATALOG FOR POSTAL.

For **multiplication** the Comptometer is four times as rapid, and for **addition** twice as rapid as the most expert mental computer.

In hundreds of Railroad and Insurance offices it is saving the salary of several clerks for each Comptometer in service, and accounts are being kept which it would not pay to keep if the computation had to be done mentally.

Used by Accountants and Engineers in all lines of business.

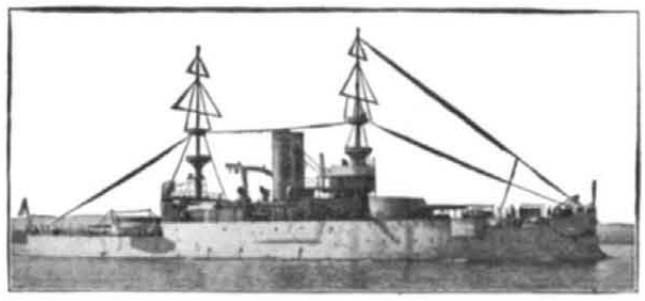
In the United States Navy Department over 85 Comptometers are used on Engineering Computation.

Nearly one thousand manufacturing and commercial firms after buying one Comptometer have ordered a **second** one, and scores have purchased and use in their accounting rooms from 10 to 25 **each.**

It insures accuracy. No lever to operate; simply touching the keys does it all. Simple, light, compact and durable. Many thousands in use.

Write for full description and sixty days' trial offer.

Felt & Tarrant Mfg. Co., 52 to 56 Illinois Street, Chicago.



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Wherever you may be—every one is praising

The Wisconsin Graphite Products

Wisconsin Graphite Paint impervious to heat, cold, acids, alkalies, sulphurous odors, smoke, salt water, etc., as applied to all exposed metal surfaces.
A FOE TO RUST
Especially recommended for boat hulls, smokestacks, etc.

Wisconsin Graphite Lubricant obviates friction. Especially recommended for light or heavy machinery.

Wisconsin Graphite Pipe Joint Paste—a foe to corrosion—a preserver of threads.

Send to-day for Free Samples and Booklet "A Life Preserver." Address Dept. S.

Wisconsin Graphite Company,
NORTH SIDE, PITTSBURG, PA.

SIX WINDINGS

will keep a Prentiss Clock running a year. It is the strongest on the market, keeps perfect time and automatically shows the correct date.

Also Frying-pan, Program and Eletrically Synchronized Clocks.

Send for Catalogue No. 1061.

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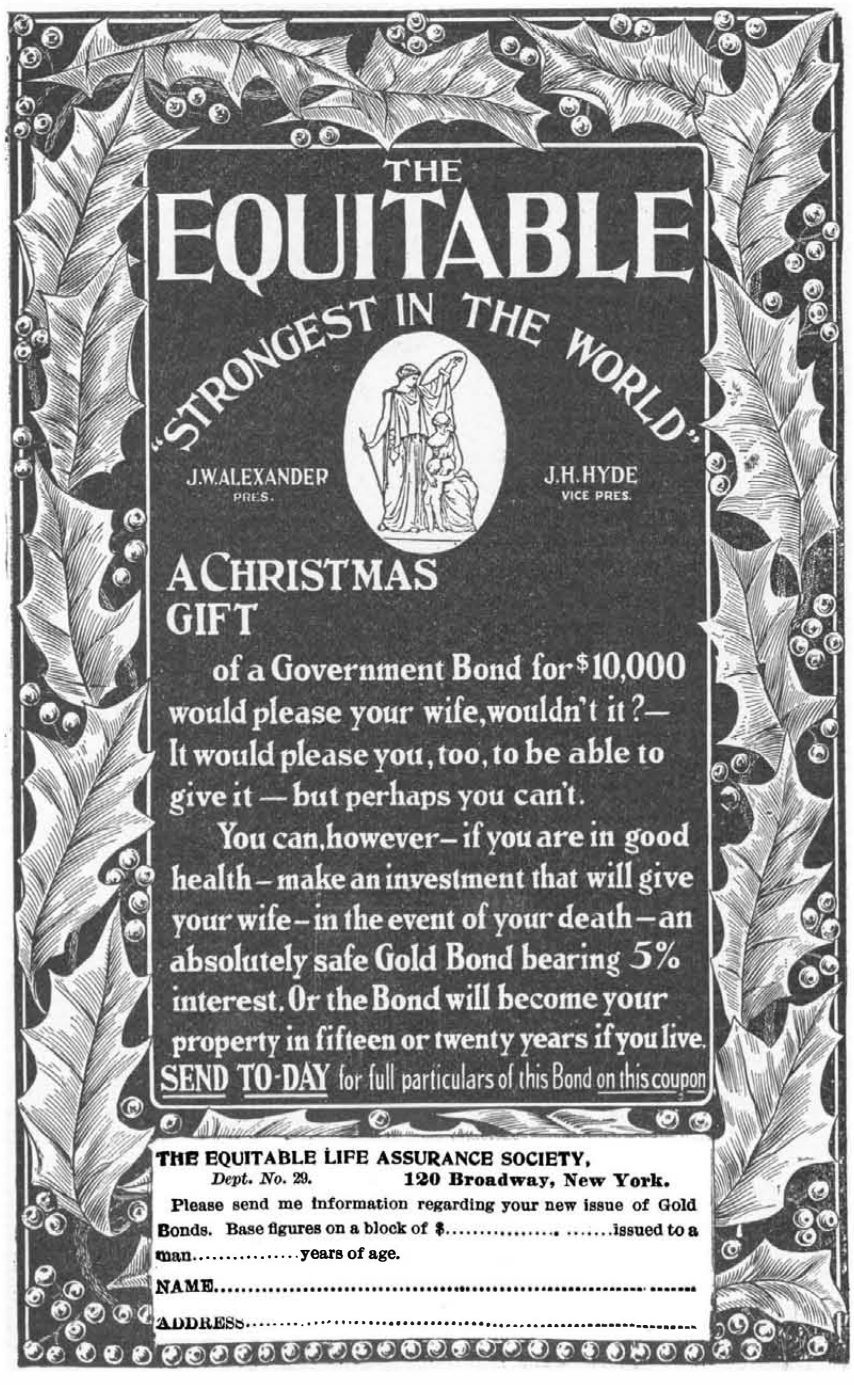
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"STRONGEST IN THE WORLD"
J.W.ALEXANDER
PRES.
J.H.HYDE
VICE PRES.
A CHRISTMAS GIFT
of a Government Bond for $10,000 would please your wife, wouldn't it?—It would please you, too, to be able to give it—but perhaps you can't.
You can, however—if you are in good health—make an investment that will give your wife—in the event of your death—an absolutely safe Gold Bond bearing 5% interest. Or the Bond will become your property in fifteen or twenty years if you live.
SEND TO-DAY for full particulars of this Bond on this coupon
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Dept. No. 29. 120 Broadway, New York.
Please send me information regarding your new issue of Gold Bonds. Base figures on a block of $..... .....issued to a man.....years of age.
NAME.....
ADDRESS.....

Brief Notes Concerning Patents.

John H. Lincoln, the inventor of the railway hay fork which bears his name, died on November 14 at Utica, N. Y., where he was visiting his daughter.

According to a recent bulletin of the Census Office, there was one patent taken out in Connecticut in 1900 for each 100 persons. In 1890 the figures were one for each 796 persons.

The Sharon Steel Company has been sued at Pittsburg for infringement. The suit is brought by J. J. Pearson & Company, of Maine, and it involves the manufacture of cement-coated nails, the object of which is to increase the tenacity of the driven nail and to preserve the substance into which the nail is driven.

C. E. Havens, foreman of the Baltimore and Ohio shops at Zanesville, Ohio, has invented an adjustable side bearing to be used on railway cars, and by the use of this improvement a car has a greater clearance in rounding curves and less friction between the bolsters. It is therefore possible to place from six to eight more cars on a train. The value of this device has been demonstrated by practical tests.

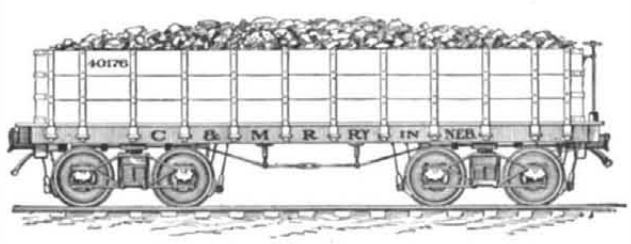
Oscar Hedstrom, who invented a motor bicycle, recently built a machine after his own design at the works of the Worcester Cycle Manufacturing Company at Middletown, Conn., of which city Hedstrom is a resident, and has shipped the machine to London, where it will be placed on exhibition. The machine was built for speed, and the inventor had been making arrangements to race it with a locomotive, but this interesting event will be interfered with by the builder's determination to send the wheel abroad.

A dispatch from St. Thomas, D. W. I., reports that an explosion of refrigerating chemicals took place on November 21 on the Royal mail steamer "Para" which did so much damage to the steamer that she was unable to proceed. The boat had just been equipped with the Lawton fruit-preserving process to enable her to compete in the fruit-carrying trade, and the inventor was making the trip personally to observe the working of the installation. He and three of his workmen were killed by the explosion, and several others were injured.

N. S. Amstutz, of Cleveland, the inventor of a process for sending pictures over wires to distant points, has recently brought out an improved process for the making of half-tone pictures for newspaper use. Its chief value is the rapidity with which a picture of this character can be made, although it has another merit, and that is that the whites are pure and solid and not broken up by dots, as is generally the case. This makes the picture crisp and sparkling because of the sharp contrasts secured in the print.

Herbert Hoyle, an Englishman, who is the inventor of a process for making artificial silk from China grass, has been brought to this country by some capitalists of Boston and vicinity with the object of exploiting his invention, and a mill will soon be in operation at Fall River or Boston. One of the advantages of Mr. Hoyle's process is that the artificial silk can be spun on ordinary cotton and woolen machines. There are a few factories in Europe for the utilization of China grass, but this is the first venture of this kind in the United States.

A patent has recently been filed in the Patent Office for a device which applies power to an automobile motor only when the driver's seat is occupied. The instant the operator rises from his seat or is thrown therefrom, the cushion is raised by means of a spring, and this carries with it a plunger which shuts off the power, and the vehicle comes to a standstill. This invention will prevent runaway accidents from automobiles. When the application for this patent was filed in the Patent Office it was found that there were twenty-six other applications covering like ideas.



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16.31 per cent. Copper per ton from BLACK HILLS COPPER CO.

The Greatest Copper Mine in the World, the Calumet and Hecla of Michigan, runs 3.05 per cent. copper, with profits paid, $75,850,000.

Prof. Lawson, in his report after examining our property, says: "The average per cent. of this body of ore is above the principal producing copper mines of the World." (See page 13 of our prospectus.)

Work is going forward on this property night and day. To install more machinery and rapidly open up the immense ore reserves, we offer for a short time, shares **at 25 cents each,** par value one dollar, full paid, and forever non-assessable.

This is not a speculation, but **a legitimate investment** in an enterprise officered by conservative business men. Remember, copper mines are the safest investments, and largest **dividend earners. $15, $25, $100 or $500 invested now promises an income for life.**

Results of work on our 11 claims are so favorable, we have just **bought 16** claims adjoining. By this consolidation we now **own 510 acres.**

Handsome Illustrated Prospectus Free.

BLACK HILLS COPPER COMPANY,

121 Territorial Street, BENTON HARBOR, MICH.

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Catalogues at all dealers.

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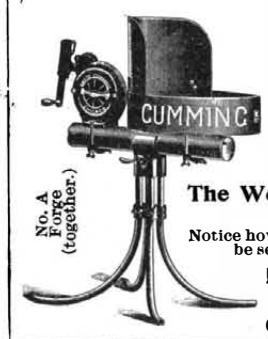
CUMMING PORTABLE FORGES (PATENTED)



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CUMMING FORGE ...is... **The World's Best Forge**

Notice how easily No. A Forge can be separated into parts

DAVID CUMMING
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CHICAGO, ILL., U. S. A.

A Comfortable Living for Fifty Years.

A thorough investigation will convince you that a few dollars per month invested for six years in the Montezuma Plantation will absolutely secure it. This is in no sense a speculation, but a solid, conservative investment, with a complete chain of safeguards around every dollar invested.

Rubber and sugar, the great staples which never fail, are being planted.

A PERFECT PLAN—RELIABLE COMPANY

The managing company has assets worth $2,000,000. The plan is the perfection of co-operation—each shareholder has only one vote, regardless of the shares held. Over two years' work, costing $50,000, has been done.

Sir Thomas Lipton says: "For sure, large and permanent returns, nothing equals a well managed Mexican plantation." Over 400 intelligent people own shares. It is as safe as life insurance, several times more profitable, and good for life.

CHICAGO TITLE & TRUST CO., Trustee.

This institution, capital $5,000,000, holds the title to the land, the purchasers' money, and a bond of $100,000, guaranteeing the development work.

Write for literature.

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ELECTRICAL WIRES
OF ALL KINDS
American Steel & Wire Co.

Chicago. New York. Worcester.
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I Pay The Freight **$25**

Will ship C. O. D. to any station in the United States for

The "WILLARD STEEL RANGE"

Has 6 8-in. lids, oven 17x12x21, 15 gallon reservoir, large warming closet, duplex grate, burns wood or coal, weighs 400 lbs., lined throughout with asbestos.

GUARANTEED TO BE AS REPRESENTED. Write for free descriptive circulars and testimonials from parties in your section who are using one.

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AGENTS WANTED TO SELL FOR CASH OR ON CREDIT.

What the Navy say of the Sanitary Still.

On your kitchen stove it furnishes plenty of distilled aerated water at trifling cost. Simple as a tea kettle.

Hon. Hilary A. Herbert, Ex-Secretary of the Navy, writes: "The Sanitary Still has been used with success in my family, and I consider the use I have made of it shows that it will afford a good supply of absolutely pure water for drinking and cooking purposes."

Admiral Dewey writes: "I join my friend, Hon. Hilary A. Herbert, ex-Secretary of the Navy, in recommending your Sanitary Still. The water from the Still is absolutely pure and palatable.

Mrs. Julia Dent Grant, widow of the famous General, writes: "I have used your Sanitary Still and am very much pleased with it. The water from the Still is pure and palatable."

The Sanitary Still is used in the "White House." Highest award at Paris Exposition. Write for booklet. **CUPRIGRAPH CO., 138 N. Green Street, Chicago.**

Automobile News.

It is intended to supplant native carriers for the transport of goods in the Congo Free State by motor cars. Several experiments have been carried out in Brussels with heavy steam lorries which would prove suitable to the country. Each vehicle was loaded with 36 hundredweight of iron and tested over rough country, typical as far as possible of that indigenous to the African state. The trials were eminently satisfactory. Each lorry will displace 65 native carriers, and the inauguration of such a service will both decrease the cost of and expedite the transit of goods into the interior.

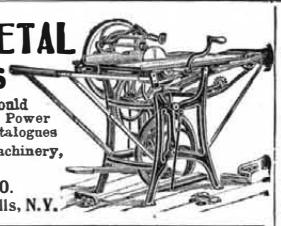
A dispatch from Odessa to The Times says that Prince Khilkoff, Russian Minister of Ways and Communications, and a party have just made a successful automobile trip from Vladikavkaz, Caucasia, to Tiflis (nearly 100 miles). The journey was the first of its kind in Russia. Prince Khilkoff is known to have a high opinion of the utility of the automobile, and, says the correspondent, he perhaps contemplates introducing it on the imperial post roads. In view of the inadequacy of the railway facilities between many important towns and the general flatness of European Russia, the automobile, the dispatch says, should prove an invaluable means of communication.

It is proposed to inaugurate a system of automobile transportation at Brussels, and an application has been made to the authorities for a concession. A series of large delivery wagons will be run over an extensive route between the city and suburbs and insure the rapid delivery of packages and merchandise. The main station will be situated at the Old Grain Market, and a number of other stations will be placed at the principal centers of traffic. The projected route is to pass by the three main railroad stations of the city. The price of transport will be fixed according to weight, with a minimum of 5 cents and a maximum of 24 cents for the heaviest packages, the limit of weight being 220 pounds. The wagons will run throughout the day (except Sundays and holidays) beginning at 7:30 A. M.

The Anniversary Run is the annual promenade which is made by the English chauffeurs to celebrate the abolition of the famous Red Flag Act, by which automobiles in England, up to November 16, 1896, could go no faster than a walk and had to be preceded by a man with a bell and a red flag. This was happily abolished by the Light Locomotives Act on that date. Last year the promenade was made from London to Southsea, and this year the chauffeurs will run to the same destination, passing by Putney Bridge, Richmond Park, Winchester, where lunch will be taken, then Waltham and Southsea. The run will be preceded by the annual dinner of the English Club which is open to all the members, these at present numbering 1,038. At a subsequent meeting the club is to discuss the question of organizing a special contest for electric automobiles.

The programme for the "Grande Semaine" at Nice, which is one of the great events of the year, has lately been published. It will commence on the 6th of April next with a parade of flower-decorated automobiles. On the 8th are two races, the Nice-Aix-Salon-Nice, a speed race of 280 miles, and the Nice-Draguignan-Nice touring race of 62 miles. On the 9th and 10th will be held an automobile show at Nice, as well as three of the principal events—the mile race and the kilometer (0.6 mile) dash for the Henri de Rothschild Cup, on the Promenade des Anglais. Then follows the famous hill-climb from Nice to La Turbie, a distance of 9.1 miles. The week finishes with a concourse of the most handsome automobiles, which will be held at Monte Carlo. Engagements are made for the whole series of races, and will be received at the Nice Automobile Club up to the 20th of March, inclusive.

WOOD or METAL Workers



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A—Wood-working Machinery,
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SENECA FALLS MFG. CO.
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ENGINE & FOOT LATHES.

MACHINE SHOP OUTFITS, TOOLS AND SUPPLIES. CATALOGUE FREE.
SEBASTIAN LATHE CO. 120 CULVERT ST. CINCINNATI, O.

Cold weather has no terrors for the wearers of the

DR. DEIMEL UNDERWEAR

No Danger of Colds.
No Danger of Rheumatism or La Grippe.
No Danger of Anything but Health and Comfort.

This Label on the Genuine.

FREE BOOKLET AND SAMPLES OF THE CLOTH BY ADDRESSING

The Deimel Linen-Mesh System Co.
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FOR LIGHT WORK.
Has These Great Advantages:

The speed can be instantly changed from 0 to 1600 without stopping or shifting belts. Power applied can be graduated to drive, with equal safety, the smallest or largest drills within its range—a wonderful economy in time and great saving in drill breakage. ☞ Send for catalogue.

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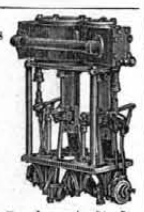
GAS and GASOLINE ENGINES

1 H. P. to 16 H. P.
MARINE and STATIONARY.

Built in accordance with the practice in Gas Engine designs. Also complete set of castings. Write for particulars.
THE CARLISLE & FINCH CO.,
220 E. Clifton Ave., Cincinnati, Ohio.

Automobile Engine for Business

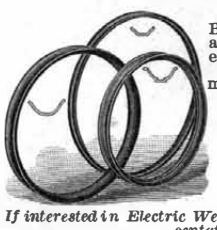
After careful testing we offer to the public, with confidence, the
S., B. & M. Compound Engine
Dimensions of Cylinder are 2¾ and 5 in. x 4 in. stroke. Height of Engine 21 in. Base 8x12 in. Weight, Engine, 95 lbs. 3 crank shaft bearings. All working bearings of bronze. Piston rods of machinery steel. Air and boiler pumps connected from cross head. Plain side valves. We also build running gears and make parts.



SHAEFFER, BUNCE & CO., - Lockport, N. Y.
Successors to SHAEFFER, BUNCE & MARVIN.

RIMS that are RIGHT

"WE MAKE THEM"



Seamless Drop Center, Flat Base and Plain Crescent Rims, all with or without flared edges.
In another department we make all sizes of
SEAMLESS STEEL TUBES,
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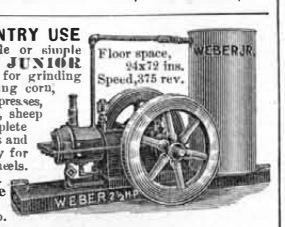
SEAMLESS STEEL BOILER TUBES, and
FLANGED BOILER HEADS.

If interested in Electric Welding write or have our representative call.

THE STANDARD WELDING CO., Cleveland, O.

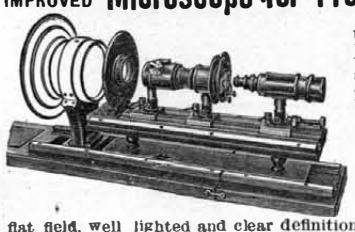
FOR TOWN OR COUNTRY USE

There is no more serviceable or simple engine than the **WEBER JUNIOR** a 2½ H. P. engine suitable for grinding feed, pumping water, shelling corn, &c., or for running fans, presses, churns, butchers' machinery, sheep shearing machines, etc. Complete with water and gasoline tanks and pipes. Oilers, etc., all ready for business. Heavy balance wheels. One operating valve. 650 lbs.



Weber Gas & Gasoline Engine Co.
Box 1114-a, Kansas City, Mo.

NEW IMPROVED **Microscope for Projection.**



New metal track plate with keys to unlock standard and change instantly—combining also polariscope and stamoscope. New series of projection objectives, with flat field, well lighted and clear definition. New substage condenser on a new system. Illustrated circular, catalogue, etc., free.
QUEEN & CO., 1010 Chestnut St., Philadelphia, Pa.

You Work YEAR AFTER YEAR

FOR
One Hundred Dollars per Month
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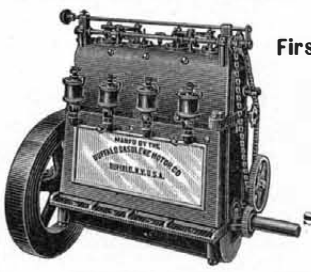

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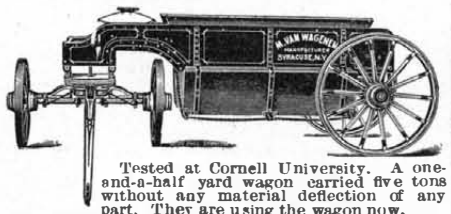

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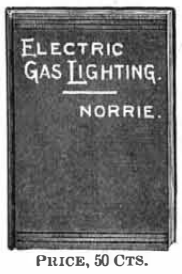

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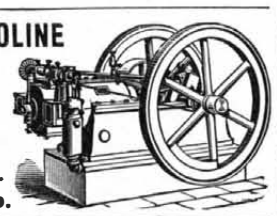

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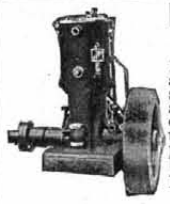

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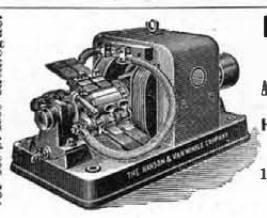

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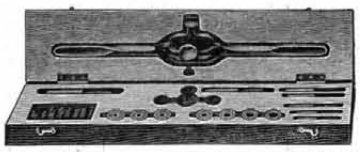

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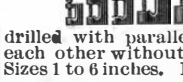

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STEAM-BOILER.—ROBERT H. BOTTS, Richmond, East Yards, Cal. The boiler has a large fire surface and a small steam area, is of small weight and especially adapted for air-ships or locomobiles. The boiler consists of a number of sets of generating chambers, each set being composed of a number of chambers concentric with each other and composed of inner and outer tubes, which are spaced apart to secure the desired steam space. Pipes are provided for the circulation of water to supply the steam chambers and to discharge the steam thence as desired.

Mechanical Devices.

CASTING-BOX.—LEO GROSSMAN, Brooklyn, New York city. Mr. Grossman has devised improvements in casting boxes for forming stereotypes, whereby a large number of plates can be successively cast in and removed from the mold or casting-box in a comparatively short time, without requiring the employment of highly-skilled labor. The casting-box has a drag; movable holders to engage the matrix at opposite sides; cores mounted to swing alternately into and out of the drag; a mechanism for imparting a simultaneously-swinging motion to the cores to move one out of the drag and the other into the drag; and means for imparting movement to the matrix-holders. The matrix can be readily changed for another one whenever required without disturbing the cores and the parts connected therewith.

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MACHINE FOR COATING EYELETS.—ISAAC W. GILES, New Bedford, Mass. In coating eyelets by means of tumbling mills, a revolving barrel is used containing a certain quantity of paint. As the articles roll in the drum they are covered with a certain quantity of the paint. It happens that the openings are filled with the japan; and the coat thus applied is ordinarily too thick. The present invention is an improved tumbling-machine by which the eyelets can be quickly coated without becoming clogged.

Designs.

SCARF.—DAVID MAYER, Brooklyn, New York city. The leading feature of the design is a scarf body having a center piece in relief on the front face of the body.

GARTER-HOOK.—LOUIS MCCUTCHON, Havana, Cuba. The shank and hook comprising the device are serpentine in shape and form a correspondingly shaped slot between them which is especially adapted to clasp and hold.

BOOK COVER.—GEORGE W. EDWARDS, Manhattan, New York city. Mr. Edwards has designed for the Funk & Wagnalls Company a cover which is to be used primarily for the Standard Dictionary. The cover is artistically designed and consists of a tasteful arrangement of conventional foliage in connection with an open book and a torch.

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CIGAR.—SIMON LEVIN, Manhattan, New York city. The design shows primarily two cigars with but a single outer wrapper. By cutting through the center angular depression of the double cigar two separate cigars are formed.

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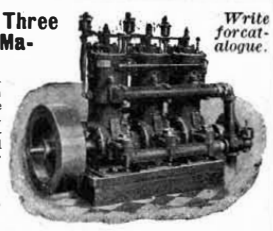

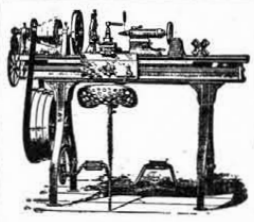

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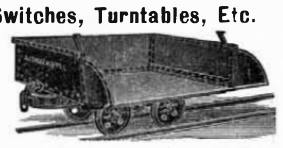

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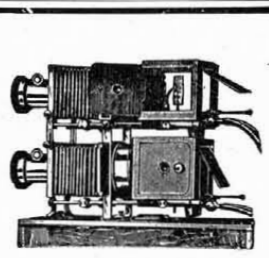

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AND EACH BEARING THAT DATE.

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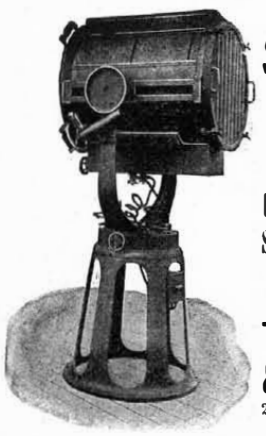

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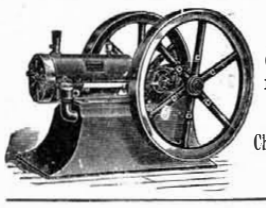

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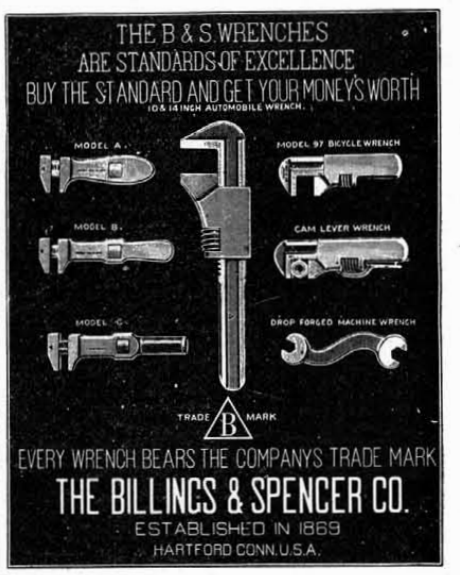
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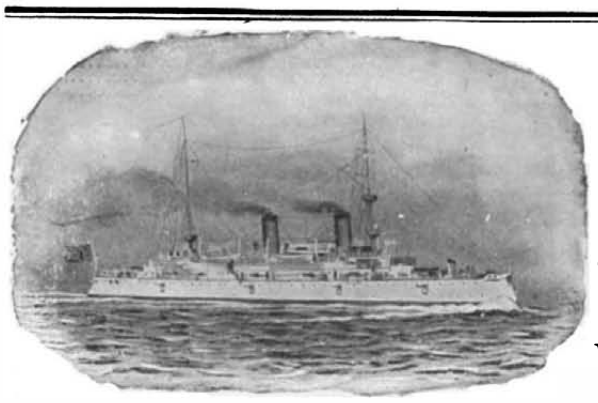

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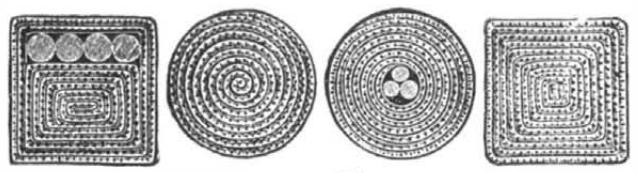

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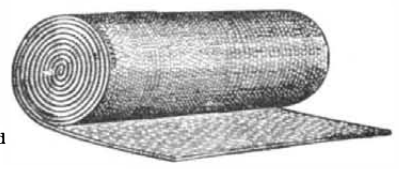

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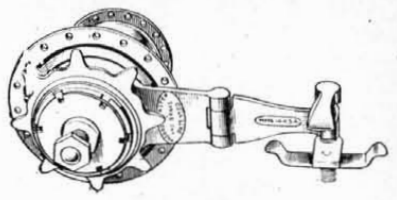

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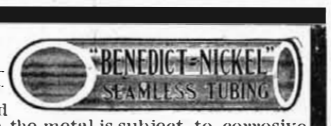

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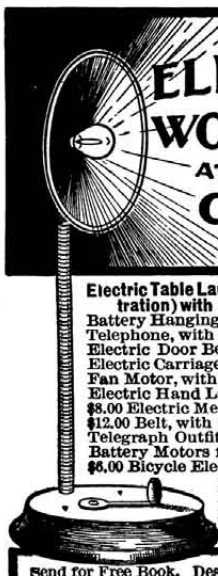

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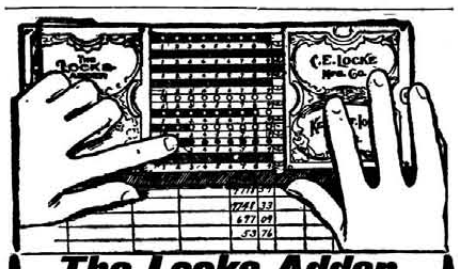

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(8472) H. L. asks: 1. Whether or not "cross talk" will be caused by having two or more lines attached to the same ground wire at the central office. A. No. 2. Also will cross talk be caused by one wire above another

(*Continued on page 398*)

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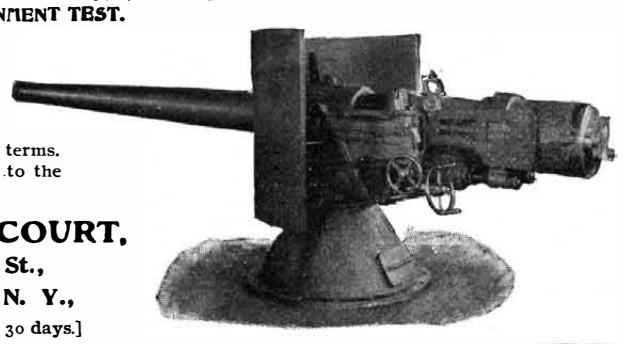

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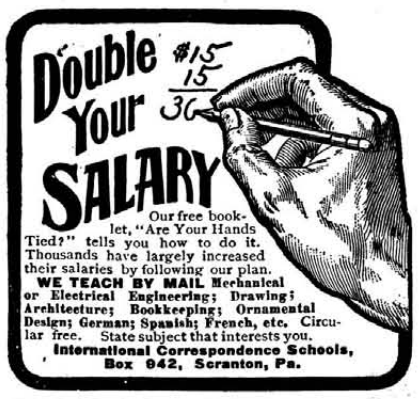

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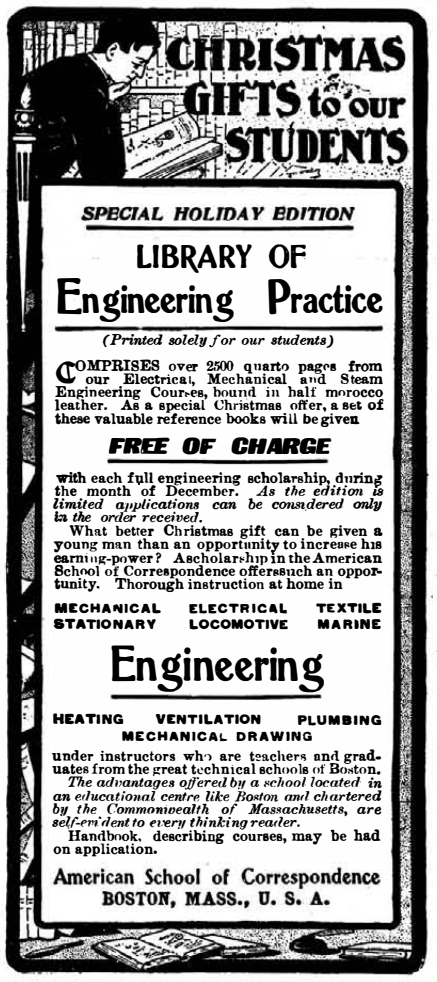

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(8473) C. C. H. writes: I was interested in the question of your correspondent, No. 8403, issue of October 26, in regard to the temperature of an iron bar in sunlight. In this instance the sense of temperature is not at fault, the temperature of iron in sunlight being higher than the temperature of the surrounding air, as the following experiment shows: In the edge of a cast-iron disk, about an inch thick by six inches broad, I bored a hole and inserted a thermometer after first filling the hole with water. The disk being stood in the sunlight out of doors, at the end of a half hour the thermometer registered 100.6 deg. The temperature of the surrounding air, also in the sunlight, found by whirling a thermometer at the end of a string, was 59.9 deg. The sky was hazy, or the difference would have been greater. The explanation is as follows: A body radiates heat at a rate nearly proportionate to the excess of its temperature above that of the surroundings, provided the excess be not too great, so that a piece of iron when placed in sunlight will rise in temperature until the loss of heat radiated is equal to that received from the sun. If we make the part of the iron not exposed to the sun a bad radiator by polishing it, and the part exposed a good absorber by smoking it, the temperature difference will become still greater. The reason that the air becomes only slightly heated by the passage of the sun's rays is that the air is a bad absorber of radiation. An interesting experiment is to lay a sheet of blackened sheet metal in the bottom of a shallow wooden box and close the box with a (or better two) cover of glass, making all as tight as possible and inserting a thermometer through a cork. In the sunlight on a hot day the temperature may rise above the boiling point of water in such a box.

(8474) W. F. B. asks: In lighting my house with incandescent lights from an isolated plant consisting of dynamo coupled to gasoline engine what effect will the variation in the number of lights used have upon the dynamo? In a mill, the motor, which receives current from a transmission line, raises the stamps 110 times per minute without any perceptible variation. Jack up all the stamps and the motor will turn the empty camshafts exactly 110 times per minute. The difference between full load and no load does not phase her a particle. An engine would race unless provided with a very sensitive automatic governor; and I suppose the motor takes only as much current as is required to make that number of revolutions. But if a 50-light direct-coupled dynamo is running and the women folks turn out all the lights in order to enjoy the moonlight, what will happen to the dynamo? A. If a miller is drawing water from his pond to run his mill, and he shuts the gate to go to dinner, what happens to his pond? Nothing. Just this will happen to your dynamo, and for the same reason. Water in the pond with the gate shut has pressure but no motion. Only pressure, electromotive force, exists in the dynamo when all the lights are turned off. There is every preparation for an outflow of electricity, but no current. Turn a switch and the current flows and the lights glow. Just as in the mill the wheels turn when the gate is opened.

on the poles (not cross armed)? A. Yes. Cross talk is produced by the wires running parallel to each other, and not by their being on the same cross arm. 3. I do not understand how every 'phone attached to the line in multiple system will reduce the resistance of the line. A. One wire has a certain resistance between two points. If we add a second wire like the first we have half the resistance, because there are two paths for the electricity, and hence twice as much can pass. 4. Does the corrosion that gathers on the zincs of a Leclanche cell impair the working of the battery? A. Yes. 5. How is polarization guarded against in those forms of the Leclanche cell having the carbon in the form of a hollow cylinder? A. By the great amount of surface it presents to the liquid. It does not prevent polarization, it only retards it. 6. Can you tell me where I may obtain directions for making a home-made galvanometer, such as would be suitable for rough-testing a 'phone generator and battery? A. In "Experimental Science," price $4 by mail. 7. Why is it harder to turn a 'phone generator when the line is grounded or when the 'phone is plugged? A. Because no current is generated when the generator is short-circuited. 8. Could you give me instructions for making a home-made blowpipe furnace? A. Pile up a few bricks around your crucible and work away. See "Experimental Science." 9. Do sharp ends of wire from one-half inch to one inch long, left projecting from any electrical connections, cause a waste of electricity? A. Not unless there is a very high potential, as in the secondary of an induction coil. 10. What is the best method for splicing small copper wires, especially No. 36 magnet wire? I have tried splicing it with an alcohol lamp, but found the flame to be too hot? A. By soldering them, using rosin as a flux. 11. Is there any method of testing the strength of the polarizing magnet of a polarized bell of a telephone? A. By finding what it will lift, or what repulsion it will exert on a magnetic needle. 12. Should oil be placed on any of the bearings of a telephone generator? A. Any part of a machine where there is rapid motion may be oiled. There is no magnetic or electrical advantage or disadvantage one way or the other.

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Julian F. Denison, New Haven, Conn.
Our advertisement brought more intelligent and valuable inquiries than any other paper.

Winton Motor Carriage Co., Cleveland, Ohio.
The only publication in which we have advertised continuously. The reason is that results have been good at all times.

Williams Brothers, Ithaca, N. Y.
We are especially impressed by the wide field covered by your circulation, and value your journal as one of the most profitable mediums for advertising that we have ever been able to find.

J. B. Colt Co., New York.
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Results have not been exceeded by any other advertising we have done.

Eclipse Mfg. Co., Elmira, N. Y.
In number and quality the returns have been equal to those of any medium and far in advance of many of your competitors.

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A large proportion of the inquiries received came from parties who appeared to be in the market for our goods. We are well pleased.

Consolidated Engine-Stop Co., Waterbury, Conn.
We did not believe it possible to receive such large returns from such a small advertisement, from Boston to South Africa.

Wisconsin Wheel Works, Racine Junction, Wis.
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Buffalo Gasoline Motor Co., Buffalo, N. Y.
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Watson McDaniel Co., Philadelphia, Pa.
Brought many inquiries from a new and valued field, heretofore not reached.

W. F. & John Barnes Co., Rockford, Ill.
Its readers are of the bright, studious, alert and interesting class and the inquiries mean business and are not from catalogue seekers.

Lowell Model Works, Lowell, Mass.
Consider the Scientific American to be an advertising medium of the first class.

Vulcan Iron Works Co., Toledo, O.
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The Warren Co., Chicago, Ill.
The advertisement has paid for itself. One order from Russia, another from British Guiana, besides many inquiries.

Cyphers Incubator Co., Buffalo, N. Y.
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Results have been far ahead of expectations. Your paper will stand well at the head of the list. Advertising all keyed.

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Farr & Farr, Chicago, Ill.
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Draper Mfg. Co., New York.
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(Continued on page 400.)

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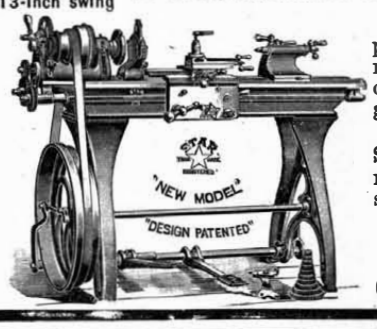

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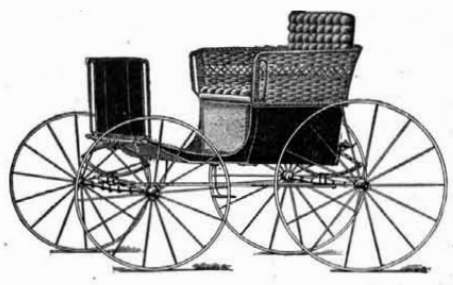

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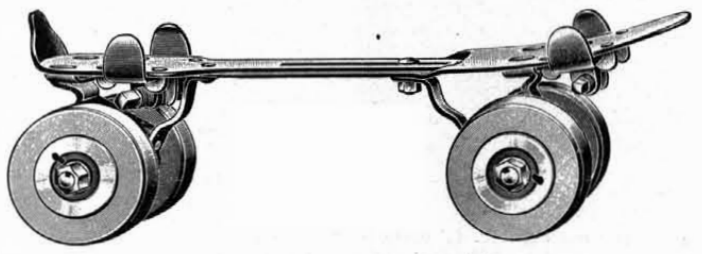

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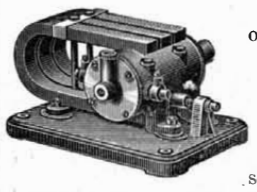

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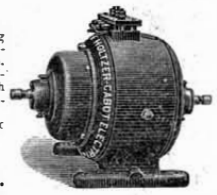

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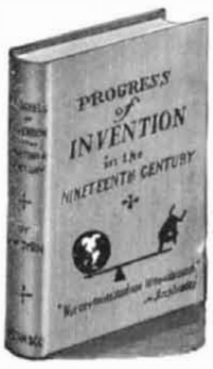

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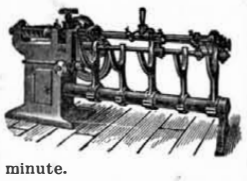

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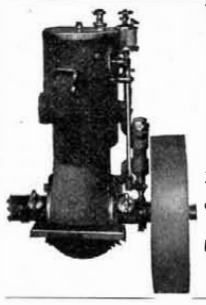

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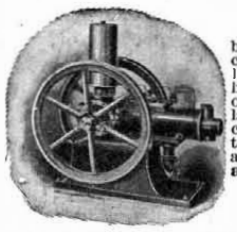

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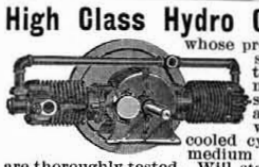

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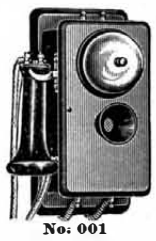

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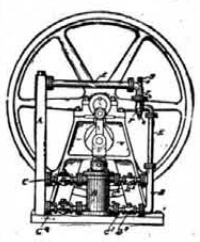

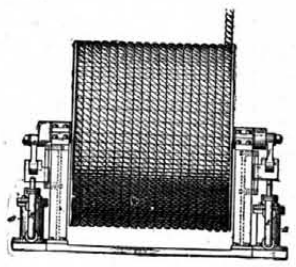

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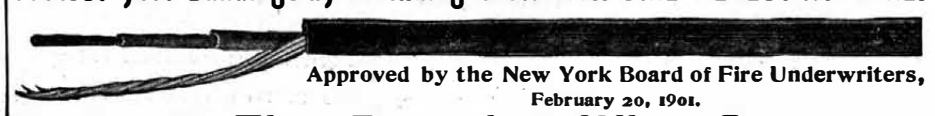

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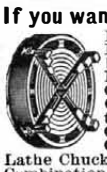

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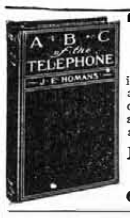

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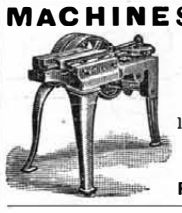

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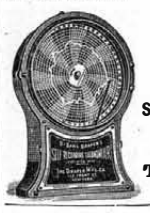

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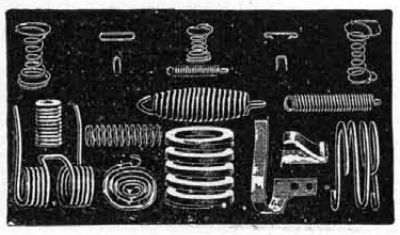

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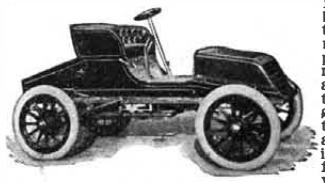

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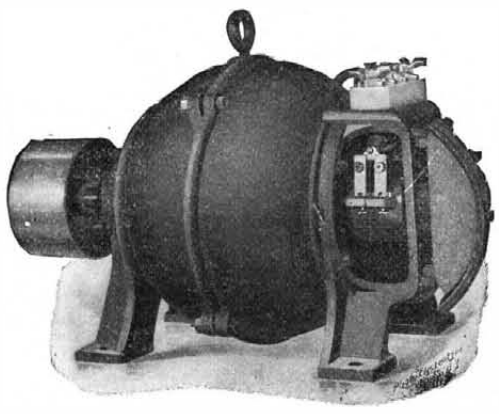

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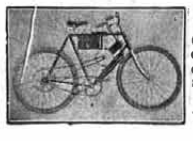

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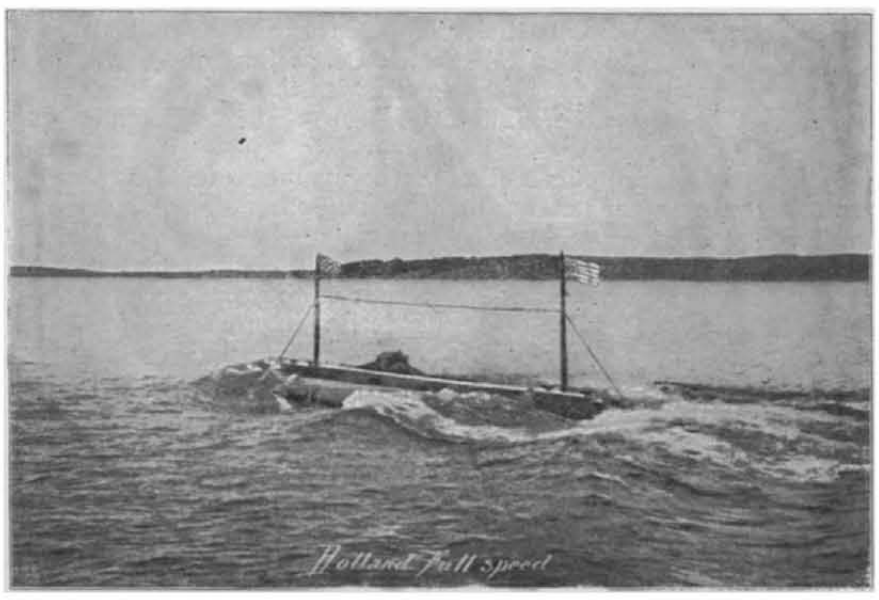

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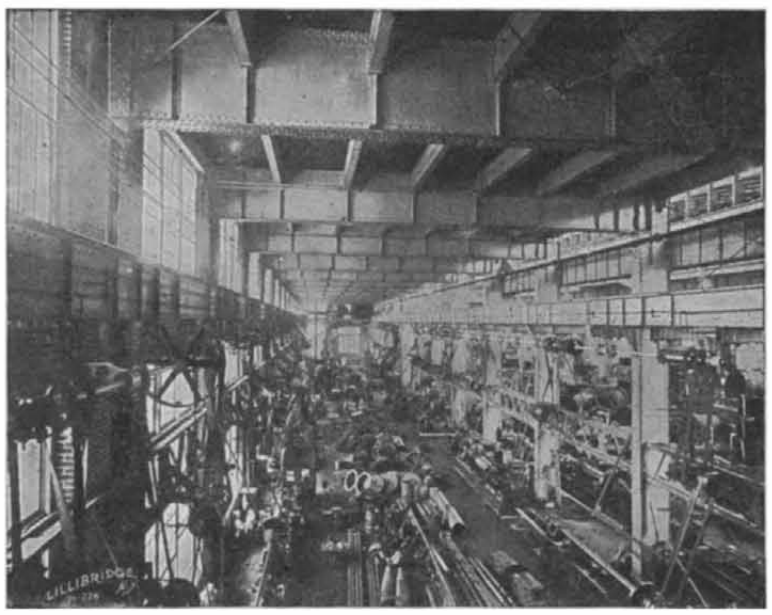

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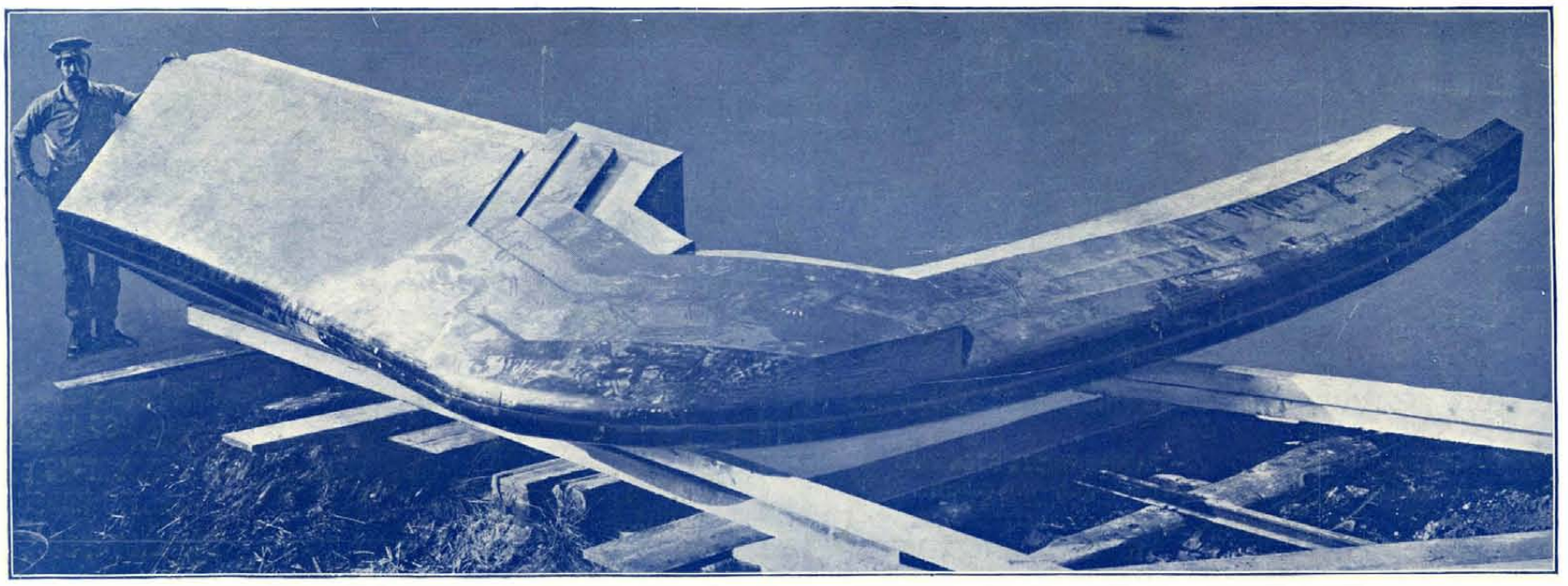

Forty-three-ton Jupiter Steel Castings for the Battleships Rhode Island and New Jersey.

MR. EUGENE EDWARDS, General Manager United States Steel Co., West Everett, Mass. BOSTON, November 9, 1901.

DEAR SIR.—The Directors of this Company realize that during your long connection with the Midvale Steel Co. of Nicetown, Pa., you personally saw much of the growth of that great steel plant, now valued at twenty millions of dollars, also that it was under your six years' management that the great steel casting plant of the General Electric Company, in Lynn, increased its output 300 per cent. They therefore desire, after your year's management of our Everett plant, that you give them your opinion as to the advisability of immediately increasing said plant to the New England demand for Jupiter Steel Castings. Respectfully,

UNITED STATES STEEL COMPANY,

Charles S. Miller *Treasurer.*

BOSTON, November 11, 1901.

UNITED STATES STEEL COMPANY, Boston, Mass.

GENTLEMEN.—I have your esteemed favor of November 9 requesting my opinion as to the advisability of increasing our present plant.

The situation briefly is as follows: With our plant at Everett we are so overrun with unsolicited business that we are constantly in danger of displeasing our customers by delay in filling orders. This condition will be partially improved as soon as our addition of 100 x 130 feet now under way is completed, and the new fifteen-ton crane in position. While this means a total of 300 feet in length for the main foundry, I am of the opinion that it should be immediately increased to 500 feet to fill the orders that the mere knowledge of our capacity would bring to us.

But there is another field for Jupiter Steel, not yet touched by our Company, which would be a very profitable one. There is a large demand in New England for heavy steel rolls in roller mills and rubber factories. These rolls weigh from 1,000 to 20,000 lbs. apiece, and we have already turned away many orders on account of being so full of other business. The making of these rolls by day, and the pouring of steel billets at night, would easily take up the capacity of another complete plant, the duplicate of our present one, of a length of 500 feet.

I believe that both of the above additions should be built immediately, and would greatly increase your dividends. You have a splendid location, with unexcelled railroad and water facilities, for the growth of a plant equal to those plants with which I have been connected and to which you refer. Very truly yours,

Eugene Edwards *General Manager.*

The above is the advice of a successful and practical steel manufacturer who found it to his advantage to leave the Midvale Steel Co. to improve his position and identify himself with the steel casting department of the General Electric Co. as Superintendent, officiating as such for six years. From the latter connection he considered it to his interest to associate himself with the United States Steel Co. as General Manager, realizing the great superiority of our product. This should be sufficient evidence of the vast strides and advance of Jupiter Steel Castings.

No branch of industry in which man engages promises a return of such handsome profits as that of the manufacture of steel. The dividends derived from the prosecution of legitimate steel manufacture far outrank the net returns from any other line of business. The wonderful stimulus which the success of the past three years has imparted to the steel business is evidenced by the tremendous outlay which has been made in this department of industry during the past year, the results of which can only be hinted at, for they will not be reducible to statistical form until 1902. It is sufficient to say that from every branch and avenue of the steel business come most favorable reports of progress and renewed achievements. The greatness of the United States lies in her internal resources, agricultural, manufacturing and mining. Agriculturally, the country is fairly well developed, in mining the same, but the manufacturing of steel has been up to within a few years a comparatively infant industry. It is in the expanding and developing of this branch of the Nation's wealth that the greatest successes of the future are to be looked for. Steel to-day is in such a position that it is right to invite capital toward its advancement. It is the mission, therefore, of everyone interested in the development of this resource to see that the industry is afforded every possible encouragement to put it to the front and let it speak for itself, for if this is done it will raise up its own friends and rally its own supporters.

The greatest publicity has been given to our enterprise, and has resulted in the present enormous demand for Jupiter Steel Castings, which are steadily and permanently displacing more expensive forms of steel, yet being of equal lightness, strength, and quality, and are an improvement over the ordinary steel casting because they require no annealing, being strictly pure steel of uniform hardness or softness throughout, and can be forged, welded and tempered.

Our foreign patents, now being negotiated, show conclusively a source of dividends equal to the entire capitalization of the Company. As a rule, stock in well-managed manufacturing companies is generally bought up by those in some way connected with their management and the outsider has little chance except at a high premium and a correspondingly low profit. But this is an unusual opportunity for people of limited means to secure an investment already paying a large income, an opportunity such as is usually offered to capitalists only, and the man with a few hundred dollars gets a chance.

In this connection it will be noted that the Scientific American published an article on Jupiter Steel, illustrated on the first page of the edition of October 12, and described in the following pages. A copy of same will be mailed on application. This was very flattering to us, and we consider it the best endorsement that Jupiter Steel has ever received.

After long deliberation we agree with our General Manager that it is to our advantage to immediately enlarge our Works to the extent recommended, to take care of the New England business that is legitimately ours, and for construction will sell 40,000 of the 230,000 shares now remaining in our Treasury, at par, $5 per share, full paid, non-assessable, and drawing full regular quarterly dividends of 3 per cent. (12 per cent. per annum), the next being payable January 27, 1902. It has been our experience that this opportunity will not long be open, as our previous offerings have invariably been over-subscribed, the last by some $25,000, which we are now filling from this block, and deem it advisable that you give our investment your prompt attention.

The United States Steel Company has been paying for the past two years quarterly dividends at the rate of 12 per cent. per annum on all its outstanding stock, and it is expected that this dividend rate will be increased as soon as we can enlarge our plant at Everett, Mass.

To those who are interested a full prospectus of the Company, together with a record of what has been accomplished in the past two years will be mailed on application. Preference will be given to subscriptions in the order of their receipt. All accepted subscriptions will draw the full regular quarterly dividend of 3 per cent. payable January 27, 1902.

UNITED STATES STEEL Co., No. 143 Oliver Street, Boston, Mass.

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